The Effects of Milk Feeding Method and Group Size on Feeding Behavior and Cross-Sucking in Group-Housed Dairy Calves

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ABSTRACT

This study investigated the effect of teat feeding and group size on cross-sucking and competition for milk in dairy calves. Ninety-six Holstein-Friesian male and female calves were allocated to either pairs or groups of 6 and fed milk either from a bucket or via a teat. Calves fed via a teat spent more time ingesting the milk. They spent time sucking the empty teat after milk intake and they spent less time cross-sucking compared with calves fed from buckets. The results show that teat feeding reduces cross-sucking in groups of 6 calves. Calves in groups of 6 ingested the milk faster than calves housed in pairs, which suggests that the competition for milk was greater than in pairs. Teat-fed calves changed to another teat more often than bucket-fed calves changed to another bucket during milk intake. Thus, the use of teat feeding did not reduce the competition for milk as compared with bucket feeding and future studies should focus on improving teat-feeding methods so that they reduce competition for milk in group-housed calves.

Key words: calf, cross-sucking, group size, milk feeding method

INTRODUCTION

When dairy calves are group-housed they can have full social contact, which they value more than social contact through bars (Holm et al., 2002), and which ensures the development of their social skills (Bøe and Færevik, 2003). However, when dairy calves are group-housed during the milk feeding period there may be problems with cross-sucking (de Passillé, 2001; Jensen, 2003), which may be intensified as the calves grow older. Cross-sucking is an abnormal behavior defined as nonnutritive sucking directed toward another calf's head or body (Lidfors, 1993). The behavior is a redirection of the natural sucking behavior, and it is stimulated by the ingestion of milk (de Passillé and Rushen, 1997). Calves fed milk via a teat perform less nonnutritive sucking of a dry teat (Veissier et al., 2002) and less cross-sucking (Løberg and Lidfors, 2001) than bucket-fed calves. Thus, cross-sucking might be minimized by providing an outlet for the natural motivation to suck in connection with milk ingestion. However, the research conducted to date is based on calves housed individually, or in groups of 2 to 3, whereas under practical conditions there are often more calves per group. Therefore, the first objective of the present study was to investigate if the effects of teat feeding also apply to calves housed in larger groups and if problems with cross-sucking are intensified toward the end of the milk feeding period.

When calves are housed in groups they compete for the milk. Competition is increased among teat-fed calves when access to teats is reduced, but the calves compete even when there is one teat per calf (Keyserlingk et al., 2004). Calves take longer to ingest milk via a teat than to drink it from the open surface in a bucket (Jung and Lidfors, 2001), and the rate of ingestion may be reduced considerably when teat feeding is used (Haley et al., 1998a). Furthermore, teat-fed calves tend to suck on the empty teat after milk ingestion. However, it is unknown if the slower rate of ingestion and the tendency to suck the empty teat after milk ingesting will reduce competition for milk in teat-fed calves compared with bucket-fed calves. Therefore, the second objective of the present study was to investigate if teat feeding reduces competition for milk in group-housed calves.

MATERIALS AND METHODS

Six blocks of 16 Holstein-Friesian male and female calves, 96 calves in total, were used. The calves were housed with their dams for the first 24 h after birth and then moved to individual straw-bedded pens (0.9 m × 1.9 m). They were housed in individual pens until they were moved to the experimental pens when the youngest calf in the block was 1 wk old. For the first 3 d the calves were offered colostrum, and from d 4 until the end of the experiment the calves were offered 6 L/d of whole milk given in 2 feedings at 0800 and 1700 h. Concentrates [Grøn Kalv Valset; DLG, Denmark

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Table 1. Description of the recorded behaviors

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingesting milk</td>
<td>The calf is ingesting milk either by sucking a teat or by drinking from an open surface</td>
</tr>
<tr>
<td>Sucking empty bucket or teat</td>
<td>The calf is sucking on an empty teat or an empty bucket, but no milk is ingested.</td>
</tr>
<tr>
<td>Cross-sucking head or neck</td>
<td>The calf is sucking on the head (nuzzle, ear or skin) or on the skin of the neck of another calf.</td>
</tr>
<tr>
<td>Cross-sucking under belly</td>
<td>The calf is sucking under the belly of another calf, mainly on navel, scrotum or udder base.</td>
</tr>
<tr>
<td>Bunting calf</td>
<td>The calf is pushing its forehead with a rapid and forceful movement against another calf’s head, neck or body.</td>
</tr>
<tr>
<td>Bunting bucket or teat</td>
<td>The calf is pushing its forehead with a rapid and forceful movement against a bucket or a teat.</td>
</tr>
<tr>
<td>Licking fixtures</td>
<td>The sucking movements are performed with the body part in the mouth.</td>
</tr>
<tr>
<td>Social grooming</td>
<td>The sucking movements are performed with the body part in the mouth.</td>
</tr>
<tr>
<td>Self grooming</td>
<td>The calf’s tongue is out of its mouth and in contact with the head, neck or body of another calf.</td>
</tr>
<tr>
<td>Inactive</td>
<td>The calf is standing or lying still.</td>
</tr>
<tr>
<td>Other activity</td>
<td>The calf is performing any activity not described above.</td>
</tr>
</tbody>
</table>

(18% CP, 4% fat, and 6% fiber), high-quality hay, and water from water bowls were offered ad libitum throughout.

Calves were assigned to blocks according to date of birth; within blocks, the calves were allocated to milk feeding method (bucket or teat) balanced for date of birth and sex. Before the calves of a block were moved to the experimental pens they were assigned to either pair housing or group housing balanced for milk feeding method and age. Thus, the treatments were 1) pair housing and bucket feeding; 2) pair housing and teat feeding; 3) group housing and bucket feeding; and 4) group housing and teat feeding. When the calves were moved to the experimental pens and the experimental period began, the calves were on average 17 (±7) d old and weighed 54 (±6.3) kg. The experimental period lasted for 6 wk and at the end of the experimental period the calves weighed 92 (±13) kg. One teat-fed calf from a group of 6 calves was removed from the pen due to arthritis, and data for this calf were not included in the analyses.

The experimental pens for pair-housed calves measured 1.94 m × 2.15 m (2.1 m²/calf) and the experimental pens for calves in groups of 6 calves measured 2.49 m × 4.15 m (1.7 m²/calf).

For bucket feeding, open steel buckets were used. For teat feeding of pair-housed calves, plastic buckets fitted with one teat (Peach Teat, Skellerup Industries, Ltd., Christchurch, New Zealand) were used. In both cases there was one bucket per calf. For teat feeding of group-housed calves, so-called teat bars (Power Feeder for 6 calves, Skellerup Industries, Ltd.) were used. The teat bars were compartmented and each compartment had one teat.

When the calves were offered the milk it was ensured that all calves in a pair or a group had access to the milk simultaneously. For pair-housed calves, 3 L of milk was poured into each of the 2 buckets simultaneously. For bucket-fed calves in groups of 6, a cover made from wire mesh was placed over the 6 buckets while 3 L of milk was poured into each of them. Once all the milk had been poured, this cover was removed and all calves in a group could start drinking simultaneously. For teat-fed calves in groups of 6, the 18 L of milk was poured so that the 6 compartments of the feeder were filled at the same time and it was ensured that all calves accessed a teat immediately after the milk was poured. For all treatments the buckets or feeders were placed in the pens just before the milk was poured and they were not removed until 30 min after.

The behavior of the calves was recorded at milk feeding in the morning by direct observations using instantaneous recording at 45-s intervals (blocks 1, 2, and 3; observer 1), or 60-s intervals (blocks 4, 5, and 6; observer 2). The recordings of calves in a group began the minute the calves in the group had access to the milk and continued for 30 min. The behaviors recorded are defined in Table 1. The calves in each block were observed by direct observations once during wk 2, 4, and 6 of the experiment.

The behavior of the calves was also recorded by video recording in wk 4 of experiment using continuous recording. These recordings were conducted at milk feeding in the morning and, like the direct observations, began the minute the calves in the group had access to the milk and continued for 30 min. Competitive behavior was observed for each calf using continuous recording. First, it was recorded whenever the calf switched from a bucket or teat that still contained milk to another bucket or teat. Second, it was recorded whenever the calf switched from one bucket or teat to another while at least one bucket or teat in the pen still contained milk.

Calves were weighed twice on 1 d in wk 4 of experiment to get an estimate of the milk intake of individual calves within the groups. All calves within each group...
were weighed immediately before and immediately after milk feeding of the calves in that group.

The behavioral data collected by direct observations were analyzed as follows. The continuous behavioral variables (ingesting milk, sucking empty bucket or teat, cross-sucking head or neck, licking fixtures, self-grooming, inactive, and other activity) were analyzed using a mixed model including the fixed effects of feeding method (bucket or teat), group size (2 or 6), feeding method × group size and week of experiment. As random effects the model included block × feeding method × group size (equal to pen) and block × feeding method × group size × week, and the covariance structure of repeated measures on the same calf was modeled as compound symmetric. The behavioral variables, which included many zero observations (cross-sucking under belly, licking calf, bunting calf, and bunting bucket or teat) were transformed into binary variables and analyzed by χ² test, or Fisher’s exact test (Siegel and Castellan, 1988), for each observation week.

From the behavioral data collected from the videotapes, the number of switches between buckets or teats was calculated for each calf. First, the number of switches from a bucket or a teat that still contained milk to another bucket or teat was calculated. Second, the number of switches from a bucket or a teat that still contained milk to another bucket or teat was calculated. These variables included many zero observations and were therefore transformed into binary variables and analyzed by χ² test.

An estimate of milk intake was calculated as the difference between the weight before and the weight after milk feeding. Within each group the difference between the minimum and maximum weight increase was calculated. This difference, which indicate the difference between the highest and the lowest milk intake within each group, was subjected to analysis using a mixed model including the fixed effects of feeding method (bucket or teat), group size (2 or 6), and feeding method × group size, while block was included as a random effect.

### RESULTS

Teat-fed calves spent more time ingesting the milk and more time sucking the empty bucket or teat after ingesting the milk (Table 2). However, teat-fed calves spent less time cross-sucking the head or neck of another calf and less time licking the fixtures (Table 2). There was no interaction between milk feeding method and group size for any of the variables. There was no interaction between milk feeding method and week, or between group size and week for any of the variables.

Calves in groups of 6 spent less time ingesting the milk than did calves housed in pairs (Table 3). Also, more calves in groups of 6 spent time on social grooming in wk 2 and fewer calves were bunting the bucket in wk 4 (Table 4).

A lower percentage of teat-fed calves were seen cross-sucking another calf under the belly in wk 4 and 6, and a lower percentage of teat-fed calves were seen licking another calf in all observation weeks (Table 4). Only teat-fed calves were seen bunting the bucket (Table 4).

The time spent sucking the empty bucket or teat decreased over the weeks of the experiment (2.06 ± 0.33, 1.86 ± 0.31, and 1.41 ± 0.27 min/feeding for wk 2, 4, and 6, respectively; \( F_{2, 45} = 4.31; P < 0.05 \)).

Teat-fed calves changed to another teat more often than bucket-fed calves changed to another bucket while there was still milk available in the teat or bucket that they left, and while there was still milk available in at least one teat or bucket in the pen (Table 5).

There was no effect of group size on the tendency to change teat or bucket while there was still milk available in the teat or bucket from which the calves were drinking. However, calves in groups of 6 changed to another teat or bucket more often than calves in pairs while there was still milk available in at least one teat or bucket in the pen (Table 5). There was a larger difference between the highest and the lowest milk intake within a group of 6 calves compared with pairs (1.78 vs. 0.64 ± 0.25 kg; \( F_{1,15} = 14.54; P < 0.01 \)), but no effect of milk feeding method on this measure.

### Table 2. Behavior at milk feeding of bucket-fed (n = 48) and teat-fed calves (n = 47); means (±SEM) are given

<table>
<thead>
<tr>
<th>Behavior, min/30-min observation</th>
<th>Bucket</th>
<th>Teat</th>
<th>( F )</th>
<th>( P &lt; )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingesting milk</td>
<td>1.39 ± 0.11</td>
<td>4.04 ± 0.19</td>
<td>( F_{1,20} = 127 )</td>
<td>0.001</td>
</tr>
<tr>
<td>Sucking empty bucket or teat</td>
<td>0.10 ± 0.11</td>
<td>5.47 ± 0.78</td>
<td>( F_{1,20} = 96.2 )</td>
<td>0.001</td>
</tr>
<tr>
<td>Cross-sucking head or neck</td>
<td>1.91 ± 0.62</td>
<td>0.16 ± 0.18</td>
<td>( F_{1,20} = 16.9 )</td>
<td>0.001</td>
</tr>
<tr>
<td>Licking fixtures</td>
<td>1.43 ± 0.24</td>
<td>0.76 ± 0.17</td>
<td>( F_{1,20} = 6.20 )</td>
<td>0.05</td>
</tr>
<tr>
<td>Self grooming</td>
<td>1.09 ± 0.18</td>
<td>0.83 ± 0.16</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Inactive</td>
<td>1.46 ± 0.50</td>
<td>0.97 ± 0.41</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Other activity</td>
<td>12.7 ± 0.89</td>
<td>12.1 ± 0.89</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Behavior at milk feeding of pair-housed (n = 24) and group-housed calves (n = 71); means (±SEM) are given

<table>
<thead>
<tr>
<th>Behavior, min/30-min observation</th>
<th>Group size</th>
<th>F</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingesting milk</td>
<td>2</td>
<td>3.03 ± 0.17</td>
<td>2.10 ± 0.13</td>
</tr>
<tr>
<td>Sucking empty bucket or teat</td>
<td>2</td>
<td>2.18 ± 0.51</td>
<td>1.38 ± 0.38</td>
</tr>
<tr>
<td>Cross-sucking head or neck</td>
<td>2</td>
<td>0.63 ± 0.37</td>
<td>0.97 ± 0.43</td>
</tr>
<tr>
<td>Licking fixtures</td>
<td>2</td>
<td>0.82 ± 0.20</td>
<td>1.35 ± 0.20</td>
</tr>
<tr>
<td>Self-grooming</td>
<td>2</td>
<td>0.98 ± 0.20</td>
<td>0.93 ± 0.15</td>
</tr>
<tr>
<td>Inactive</td>
<td>2</td>
<td>1.32 ± 0.50</td>
<td>1.09 ± 0.40</td>
</tr>
<tr>
<td>Other activity</td>
<td>2</td>
<td>11.9 ± 0.93</td>
<td>12.8 ± 0.86</td>
</tr>
</tbody>
</table>

DISCUSSION

The results show that teat feeding reduced the occurrence of cross-sucking equally in pair-housed and group-housed calves. Irrespective of group size, teat-fed calves took longer to ingest the milk compared with bucket-fed calves and they kept on sucking the empty teat after the milk was ingested. On the contrary, the bucket-fed calves left the bucket soon after it was empty and often turned to cross-suck on other calves. During the 30 min immediately after milk feeding, when the behavioral recordings were made, most cross-sucking was directed to the head and around the muzzle, which was smeared with milk. However, cross-sucking under the belly was observed in many of the calves and in wk 4 and 6 of experiment this behavior was seen more in the bucket-fed calves, which suggests that problems due to cross-sucking may be intensified over the milk feeding period. The sucking under the belly is of special concern, as it may lead to intersucking in heifers and milk stealing in cows (Keil and Langhans, 2001).

Table 4. Behavior at milk feeding of bucket-fed (n = 48) or teat-fed (n = 47), and pair-housed (n = 24) or group-housed (n = 71) calves

<table>
<thead>
<tr>
<th>Behavior, % of calves&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Milk feeding method</th>
<th>Group size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bucket</td>
<td>Teat</td>
</tr>
<tr>
<td>Cross-sucking under belly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>Week 4</td>
<td>38</td>
<td>8</td>
</tr>
<tr>
<td>Week 6</td>
<td>38</td>
<td>4</td>
</tr>
<tr>
<td>Social grooming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td>71</td>
<td>40</td>
</tr>
<tr>
<td>Week 4</td>
<td>74</td>
<td>48</td>
</tr>
<tr>
<td>Week 6</td>
<td>72</td>
<td>52</td>
</tr>
<tr>
<td>Bunting calf&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Week 4</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Week 6</td>
<td>15</td>
<td>25</td>
</tr>
<tr>
<td>Bunting bucket&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>Week 4</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Week 6</td>
<td>0</td>
<td>13</td>
</tr>
</tbody>
</table>

<sup>1</sup>Percentage of calves performing each behavior in wk 2, 4, and 6.

<sup>2</sup>Fisher’s exact test.
The results suggest that competition for milk was higher among calves in groups compared with calves in pairs. First, the rate of ingesting milk was higher in group-housed calves than in pair-housed calves. Second, calves in groups changed more often to another teat or bucket than calves in pairs while there was still milk available in at least one of the teats in the pen. A higher rate of switching while there was still milk in at least one of the teats in the pen may be explained by uncertainty of where the remaining milk was. To maximize milk intake the calf should switch to one of the other teats as soon as the teat that the calf is on is empty. One explanation for less switching among bucket-fed calves could be that the calves could see which buckets were empty. Chua et al. (2002) found a low frequency of teat displacements in pair-housed calves fed ad libitum and the teat switching may be a problem only if low milk allowances are used and calves are still hungry when they have ingested their own milk ration. Competition for milk clearly depends on milk allowance. Holstein-Friesian calves with ad libitum access to milk consume approximately 9 L/d of milk (Jasper and Weary, 2002), which is 50% more than the amount offered in the present experiment.

Bucket-fed calves were more often observed licking the fixtures of the pen and more bucket-fed calves were observed performing social grooming compared with teat-fed calves. More oral activity directed toward fixtures of bucket-fed compared with teat-fed calves have been reported earlier (Veissier et al., 2002), and the more social grooming is possibly a side effect of the more cross-sucking of bucket-fed calves.

The results suggest that competition for milk was higher among calves in groups compared with calves in pairs. First, the rate of ingesting milk was higher in group-housed calves than in pair-housed calves. Second, calves in groups changed more often to another teat or bucket than calves in pairs while there was still milk available in at least one teat or bucket in the pen. A higher rate of ingestion, which may be taken as indicative of social constraint (Nielsen, 1999), has also been found in group-housed compared with individually housed calves when the milk was offered in a trough (Babu et al., 2004). Also, among calves fed from a computer-controlled milk feeder (in which the calves could not steal milk from each other but competed for access to the feeder), the rate of ingestion was higher in groups of 24 compared with groups of 12 (Jensen, 2004). The finding that the difference between minimum and maximum milk intake was larger in group-housed than in pair-housed calves has to be interpreted with caution, because range may increase with sample size. It was hypothesized that the teat feeding would reduce competition for milk among the group-housed calves in the present study. However, this was not found. The competition for milk in group-housed calves is intensified on low milk allowances. Therefore, when milk is fed restrictively it is essential that milk stealing is limited to ensure minimal variation in milk intake within the group. Future studies should focus on improving milk feeding methods for group-housed calves so that competition, as well as variation in milk intake, within groups of calves is minimized.

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REFERENCES


