Short communication: Effects of bedding quality on the lying behavior of dairy calves

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ABSTRACT

The lying behavior of adult cattle is strongly affected by characteristics of the lying surface, but no previous work has assessed the effects of lying surface for dairy calves. We evaluated how the lying behavior of dairy calves changed when calves were provided sawdust-bedded versus concrete lying surfaces, and in response to variation in dryness of the sawdust bedding. Five Holstein calves, approximately 2-wk old, were individually housed in pens with half of the lying surface bedded with kiln-dried sawdust [90% dry matter (DM)] and the other half with wet bedding varying in DM at 4 levels (74, 59, 41, and 29%) or bare concrete. All calves were tested on all 5 treatments, with treatment order assigned using a 5 × 5 Latin square. Total lying time averaged 17.2 ± 0.1 h/d and did not vary with treatment, but time lying on the wet bedding decreased from 5.3 ± 1.1 h/d at 74% DM to almost zero at 29%. Lying times on the side of the pen with dry bedding varied from 12.2 ± 1.2 h/d (when the wet bedding was 74% DM) to 16.8 ± 1.2 h/d (at 29% DM). Standing times were higher on the dry than the wet bedding (2.6 vs. 1.7 ± 0.1 h/d) but did not change across the range of bedding DM tested on the wet side. No calves ever lay down on the bare concrete. In conclusion, dairy calves showed clear preference for drier sawdust bedding and aversion to concrete lying surfaces, indicating that access to soft and dry bedding is important for growing calves.

Key words: calf welfare, comfort, preference testing, bedding management

Short Communication

Lying behavior is important for adult cattle; they are highly motivated to rest (Jensen et al., 2004) and show decreased plasma concentration of growth hormone (Munksgaard and Løvendahl, 1993), elevated levels of

plasma cortisol, and other indicators of stress after just a few hours when prevented from lying down (Fisher et al., 2002; Tucker et al., 2007). Previous work has shown that housed cattle are motivated to lie down for approximately 12 h/d (Jensen et al., 2004; Jensen et al., 2005). After a period when prevented from both lying down and feeding, cows will delay feeding to lie down (Cooper et al., 2007).

Lying behavior may be influenced by several factors such as overstocking (Fregonesi et al., 2007a), low space allowances (Færevik et al., 2008), lameness (Chapinal et al., 2009), feeding management (De Vries et al., 2011), lying area design (Tucker et al., 2004; Fregonesi et al., 2009a,b), and type of lying surface (Tucker et al., 2003; Wagner-Storch et al., 2003). The quantity and quality of bedding provided are especially important. Cows spend more time lying down when stalls contain more bedding (Tucker and Weary, 2004; Tucker et al., 2009), and lying times decrease when sand-bedded stalls are not leveled (Drissler et al., 2005) or when sawdust bedding becomes wet (Fregonesi et al., 2007b; Reich et al., 2010).

Lying down is likely also important for growing cattle. Dairy calves typically spend about 18 h/d lying down (Wilson et al., 1999; Chua et al., 2002; Panivivat et al., 2004) and some data suggest that inadequate lying times reduce growth (Mogensen et al., 1997; Hänninen et al., 2005). Lying behavior also has been used as indicator of how well calves adjust to new housing (Veissier et al., 1989; von Keyserlingk et al., 2011).

Unfortunately, little is known about the effects of housing features on the lying behavior of calves. The results of one earlier study showed that hard lying surfaces decreased lying time and affected the lying posture of calves (Le Neindre, 1993), but another study (Hänninen et al., 2005) found little difference in lying behavior of the calves kept on concrete versus rubber mats. A recent Canadian survey indicated that most farms keep dairy calves on concrete flooring with some straw or sawdust bedding (Vasseur et al., 2010), but little is known about the quality of this bedding and how properties of the lying surface may affect the calves.

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Dry bedding is likely important for calves. Dry bedding can reduce heat loss through conduction, helping the animals to cope with cold environments; the lower critical temperature for young calves is 18°C when they lie down on concrete versus 6°C when they lie down on deep dry straw (Wathes et al., 1983; Webster, 1984). Lago et al. (2006) surveyed naturally ventilated calf barns during winter in North America and observed that wet bedding material reduced the ability of calves to nestle into the bedding. Ninomiya and Sato (2009) found that greater amounts and more frequent additions of bedding increased the use of lying posture related to sleeping and comfort in calves.

The aim of the current study was to determine how calf preference for a lying surface varies with the presence of sawdust bedding and the DM of this bedding. We predicted that dairy calves would avoid wet sawdust and avoid concrete flooring without bedding.

All calves were cared for under the guidelines established by the Canadian Council on Animal Care (2009). We used 5 Holstein calves with a mean $\pm$ standard deviation BW of 51.2 ± 4.3 kg and age of 13.4 ± 1.8 d, kept in a naturally ventilated calf barn. During the study, temperature and humidity inside the barn averaged $9.3 \pm 2.3^\circ\text{C}$ (minimum of 4°C and maximum of 19°C) and $67.8 \pm 11.4\%$, respectively. Calves were fed 8 L/d of pasteurized whole milk using twice daily feedings from bottles.

Before calves were enrolled in this study they were kept in individual pens (1.96×1.27 m) with solid plastic walls on 3 sides. At the front of the pens were galvanized steel gates used to secure plastic buckets containing water and calf starter provided ad libitum. These pens were bedded with the same sawdust bedding used in the experiment. When the study began, the walls between pairs of adjacent pens were removed, allowing each experimental calf access to a double pen (i.e., 1.96×2.54 m).

During a 3-d acclimatization period, each double pen was bedded with 30 kg of kiln-dried sawdust (average $\pm$ SD $90 \pm 0.2\%$ DM). After this period, one side (left or right, assigned at random) of each of the 5 double pens was bedded with 15 kg of $90 \pm 0.2\%$ DM sawdust and the other side of the double pen was bedded with an identical quantity of sawdust with 1 of 4 levels of DM (74 ± 0.3 , 59 ± 0.4 , 41 ± 0.25 , or $29 \pm 0.5\%$).

As a negative control, we included a fifth treatment of bare concrete. The 4 different bedding DM levels were obtained by mixing 15 kg of dry sawdust with 3.4, 8.0, 18.0, and 38.0 L, respectively, of water in a cement mixer. Bedding management and sampling followed the methodology described by Reich et al. (2010). Each animal was tested on each treatment for 24 h, with treatment order allocated across the 5 pens using a 5×5 Latin square.

This Latin square was applied twice, yielding 2 d of data for each treatment. These data were then averaged to provide 1 observation per treatment per pen for use in the analysis.

Behavior was recorded 24 h/d using a camera (WV-BP334; Panasonic, Suzhou, China) placed above each pen. Red lights (100 W) were hung adjacent to the cameras to facilitate video recording at night. Video recordings were scanned at 5-min intervals; each scan recorded if the calf was standing or lying down and if the calf was fully or predominantly on the side of the experimental pen with dry or wet bedding. When animals were standing or lying down half on one side and half on the other side, we defined the location as where the animal's head was positioned.

Two data loggers (Hobo Temperature/Relative Humidity Data Logger; Onset Computer Corp., Pocasset, MA) that recorded temperatures every 10 min were placed at either side of the calf pens to record daily minimum and maximum temperatures. The effects of pen side (i.e., dry versus wet) and bedding DM (on the wet side) were tested using Proc Mixed of SAS (version 9.2; SAS Institute Inc., Cary, NC), with calf specified as a random effect.

Calves preferred to lie down on the dry compared with wet bedding (Figure 1a; $F_{1,4} = 238.68$, $P < 0.001$), especially when the bedding was very wet (interaction between bedding DM and pen side; $F_{3,12} = 6.77$, $P = 0.006$). The time calves spent lying down on the wet side decreased with decreasing bedding DM from approximately 5 h/d on the driest of the alternatives (74% DM) to near zero on the wettest treatment ($F_{3,12} = 5.40$, $P = 0.014$). In contrast, lying time on the dry side averaged approximately 12 h/d on the 74% DM treatment, increasing to almost 17 h/d on the wettest treatment ($F_{3,12} = 3.75$, $P = 0.04$). Calves never chose to lie down on the bare concrete surface and instead spent all of their lying time (17.4 ± 0.33 h/d) on the side of the pen with dry bedding.

Calves preferred to stand on the side of the pen with dry bedding (Figure 1b; $F_{1,4} = 20.56$, $P = 0.01$). This preference did not change across the range of bedding DM tested on the wet side and no interaction was observed between bedding DM and pen side.

Lying behavior is an important activity for dairy calves, occupying about 70 to 80% of the day (Panivivat et al., 2004; Hänninen et al., 2005). Total lying times observed in the current study (approximately 17 h/d) are consistent with the values reported in this previous research.

The results from this study are consistent with earlier work on adult dairy cows showing decreased lying times on wet bedding (Keys et al., 1976; Fregonesi et al., 2007b; Reich et al., 2010). Reich et al. (2010) also

Figure 1. Least squares means $\pm$ SE time (h/d) calves spent A) lying down and B) standing up on the side of a double pen with wet sawdust bedding (Wet; bedding DM varied from 74 to 29%) or the side with kiln-dried sawdust bedding (Dry; 90% DM).

tested a range of bedding DM contents, but found the largest decreases when bedding DM was less than 60%. In the current study, calves always preferred the driest surface. This preference was near absolute when tested with the wettest treatment (29%) but calves spent several hours a day lying down on the 59% DM bedding.

When calves were free to lie down on either kiln-dried bedding or bare concrete, they never chose the latter, indicating that a concrete surface is aversive. Previous work on calves (Le-Neindre, 1993) and adult cattle (Haley et al., 2001; Wagner-Storch et al., 2003) has also shown an aversion to bare concrete surfaces.

One reason why cattle may avoid wet bedding is that wet surfaces will increase heat loss from conduction and evaporative cooling. The current study was carried out during winter, but temperatures within the calf barn were mild and always in excess of the reported lower critical temperature of 0°C for 1-mo-old calves (Wathes et al., 1983).

The effects of cooling should be greatest when a large part of the calf's body surface is in contact with the wet surface, so this effect is unlikely to explain why calves also avoided standing on wet bedding. The preference for a dry standing surface may be due in part to this being the preferred lying surface and calves simply

spent more time standing in the area where they also preferred to lie down.

The results of our study illustrate the importance of providing a dry bedded lying surface to young calves. Depth of bedding was not investigated, but calves may benefit from deep bedding, as this allows them to nestle into the bedding, perhaps reducing heat loss via radiation and convective cooling. Deep, dry bedding may be a more effective method of managing for drafts and cold stress than is enclosure of the pen (Lago et al., 2006).

One criticism of our design is that calves were familiar with the dry bedding, because this was always available as a lying surface and because it was used during the acclimatization period. Preference for the dry bedding may have been driven by familiarity. However, the calves in this study had been exposed to bedding varying in DM before the experiment began. The DM of the bedding in the home pens was not monitored, but previous research on commercial farms showed that bedding DM averaged 48% and ranged from 68 to 27% (Lago et al., 2006).

In conclusion, dairy calves showed a clear preference for a dry sawdust-bedded lying surface; they avoided lying on wet bedding, especially when bedding DM was 59% or less. These results indicate that access to a soft, dry lying surface is important to dairy calves.

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