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Cow comfort in tie-stalls: Increased depth of shavings or straw bedding increases lying time

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ABSTRACT

Over half of US dairy operations use tie-stalls, but these farming systems have received relatively little research attention in terms of stall design and management. The current study tested the effects of the amount of 2 bedding materials, straw and shavings, on dairy cattle lying behavior. The effects of 4 levels of shavings, 3, 9, 15, and 24 kg/stall (experiment 1, n = 12), and high and low levels of straw in 2 separate experiments: 1, 3, 5, and 7 kg/stall (experiment 2, n = 12) and 0.5, 1, 2, and 3 kg/stall (experiment 3, n = 12) were assessed. Treatments were compared using a crossover design with lactating cows housed in tie-stalls fitted with mattresses. Treatments were applied for 1 wk. Total lying time, number of lying bouts, and the length of each lying bout was recorded with data loggers. In experiment 1, cows spent 3 min more lying down for each additional kilogram of shavings (11.0, 11.7, 11.6, and 12.1 ± 0.24 h/d for 3, 9, 15, and 24 kg/stall shavings, respectively). In experiment 2, cows increased lying time by 12 min for every additional kilogram of straw (11.2, 12.0, 11.8, and 12.4 ± 0.24 h/d for 1, 3, 5, and 7 kg/stall of straw, respectively). There were no differences in lying behavior among the lower levels of straw tested in experiment 3 (11.7 ± 0.32 h/d). These results indicated that additional bedding above a scant amount improves cow comfort, as measured by lying time, likely because a well-bedded surface is more compressible.
Key words: bedding, cow comfort, tie-stall, behavior

INTRODUCTION

Housing for dairy cattle is receiving a growing amount of attention in both the scientific literature and in the dairy industry. Dairy cattle generally spend 8 to 16 h/d lying down and there is growing evidence that lying is a priority for cows. For example, cows kept in tie-stalls will complete an operant task to maintain lying times of 12 or more hours per 24 h (Jensen et al., 2005). If lying behavior is disturbed for several hours per day, cattle will choose to lie down rather than feed (Metz, 1985; Munksgaard et al., 2005).

There is increasing evidence that bedding plays a key role in maintaining and promoting cow comfort, as measured by health and behavior. For example, bedding plays an important role in the development, prevalence, and severity of leg injuries. Cows moved from pasture to scantily bedded mattresses will quickly (within 3 to 6 wk) develop hock lesions (Mowbray et al., 2003), and lying surface is an important risk factor for lesions (Weary and Taszkun, 2000; Wechsler et al., 2000; Fulwider et al., 2007). Front legs are also affected by the lying surface. Cows kept on concrete were 3 times more likely to have swollen carpal joints compared with cows kept on rubber mats (Rushen et al., 2007), and cows housed on abrasive surfaces such as recycled sand were more likely to experience hair loss and swelling in the carpal joints (Fulwider et al., 2007). Injuries to both the front and hind legs were lowest in compost or straw systems compared with stalls fitted with mattresses or concrete, respectively (Fulwider et al., 2007; Schulze Westerath et al., 2007).

The amount of bedding influences lying time and structure of lying bouts throughout the day. Lying times were reduced when dairy cattle were housed without bedding (Haley et al., 2001; Rushen et al., 2007). In addition, lying times decline when less bedding is used. In sand-bedded free stalls, every 1-cm decline in bedding depth reduced lying time by 10 min/d (Drissler et al., 2005). With sawdust-bedded mattresses, lying time decreased 12 min/d for every 1-kg reduction in sawdust use (Tucker and Weary, 2004). The softness or compressibility of the lying surface may underlie the behavioral response to the amount of bedding. To date, studies on this topic have measured the amount of bedding by weight or depth. Although weight and depth are useful descriptors from an experimental perspective

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(i.e., repeatable), these measures provide little insight into which physical feature of bedding is important to dairy cattle.

Specific animals may be disproportionately affected by bedding levels. Heavy or large cows may perceive the softness of the lying area differently than smaller cows. Cows often respond to scantily bedded stalls by lying down less often (Tucker and Weary, 2004), perhaps because of the considerable weight placed on the knees during the transition from standing to lying. Thus, the hypothesis was that the comfort of heavy cows would be more affected by bedding levels than would that of lighter cows.

Much of the research has focused on free stalls, but many producers use tie-stalls to house cows (63% of US dairy operations; USDA, 2007) and there are considerable problems with injuries in these systems (Zurbrigg et al., 2005). The type of bedding used in both free- and tie-stalls varies with geographic region and availability; thus, 2 commonly used materials, straw and wood shavings, were compared. The objective was to evaluate how the amount and compressibility of these bedding materials affected the lying behavior of cows housed in tie-stalls.

MATERIALS AND METHODS

The study was conducted in the tie-stall dairy facility located at Agriculture and Agri-Food Canada's Research Centre in Lethbridge, Alberta, Canada. All cows were cared for under the guidelines established by the Canadian Council on Animal Care (1993).

Experiments 1 and 2

Kiln-dried shavings were used as the bedding source in experiment (**Exp.**) 1 and chopped straw was used in Exp. 2. Twelve lactating cows were randomly assigned to each experiment; 6 primiparous (mean ± SD; BW, 621 ± 83 kg; DIM, 107 ± 28) and 6 multiparous (BW, 727 ± 29 kg; DIM, 162 ± 55) in Exp. 1 and 7 primiparous (BW, 645 ± 78 kg; DIM, 164 ± 57) and 5 multiparous (BW, 666 ± 32 kg; DIM, 166 ± 19) in Exp. 2. The range of BW was 538 to 772 kg in Exp. 1 and 543 to 794 kg in Exp. 2. In each experiment cows received 4 levels of bedding over time; 1, 3, 5, and 7 kg/stall of straw in Exp. 1 (0.4, 1.3, 2.1, and 2.9 kg/m^2) and 3, 9, 15, and 24 kg/stall of shavings in Exp. 2 (1.3, 3.8, 6.3, and 10.0 kg/m^2). The range of bedding levels was chosen to reflect the range observed on commercial farms. The lowest levels barely covered the mattresses at the base of the stall, whereas the highest level of bedding provided an extremely well bedded option. Each cow was tested with each bedding level for 1 wk. Treatment was assigned randomly within the constraint that the number of cows on each treatment was equal and balanced across time.

The stalls measured 180 cm long × 132 cm wide and were fitted with mattresses (Cozy Cow, Roth Manufacturing Co., Loyal, WI). The stalls were bedded once daily. The bedding was applied to the stalls when the cows were let out of the barn for exercise from approximately 0730 to 0900 h. During the day, manure was routinely cleaned from the back of the stalls into an uncovered gutter behind the stalls, and any bedding that had moved laterally into the adjacent stalls was repositioned.

Lying times were monitored using Gemini Data Loggers (Gemini Inc., Chichester, UK; previously validated by O'Driscoll et al., 2008). Loggers were placed on the hind leg along the metatarsus bone and moved to the alternate leg on alternate weeks. This device used a mercury switch to determine leg orientation (standing versus lying) and was programmed to record position every 1 min. Before placing the logger on the cow, a band of Co-Flex Cohesive Flexible Bandage (Andover Coated Products Inc., Salisbury, MA) was placed around the leg. Petroleum jelly (Vaseline Intensive Care, Chesebrough-Ponds, Greenwich, CT) was spread over the bandage around the area where the logger was positioned to minimize irritation. Loggers were placed inside durable fabric pouches padded with 2 cm of foam, and wrapped around the leg with Velcro (Velcro Industries BV, Manchester, NH) and secured with cohesive bandage.

Cows were milked in their stalls twice daily at 0630 and 1630 h and milk production was recorded. All cows were fed a standard lactation TMR formulated using the Cornell-Penn-Miner system (CPM Dairy, Version 2.12; Cornell University, Ithaca, NY; University of Pennsylvania, Kennett Square, PA; and William H. Miner Agricultural Research Institute, Chazy, NY) for cows producing 35 kg/d of milk with 3.5% fat and 3.2% protein. Cows were fed for ad libitum intake (10% orts, DM basis) at 1300 h each day with feed pushed up or topped up 3 to 4 times during the day as required. This feeding routine was similar across treatments. Cows had free access to water.

Experiment 3

The third experiment tested lower levels of straw bedding. Six primiparous (BW, 580 ± 61 kg; DIM, 138 ± 33) and 6 multiparous (BW, 628 ± 37 kg; DIM, 87 ± 61) cows were each tested with 4 levels of chopped straw bedding: 0.5, 1, 2, and 3 kg/stall (0.2, 0.4, 0.8,