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Effects of alternative deep bedding options on dairy cow preference, lying behavior, cleanliness, and teat end contamination

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ABSTRACT

Cows spend more time lying down when stalls are soft and dry, and bedding plays a key role in the comfort of the lying surface. The first objective of this study (experiment 1) was to compare cow preference for 2 types of alternative deep-bedding materials, switchgrass and switchgrass-lime, using wheat straw on a rubber mat as a control. Nine Holstein lactating cows were submitted in trios to a 3-choice preference test over 14 d (2 d of adaptation, 3 d of restriction to each stall, and 3 d of free access to all 3 stalls). Cows were housed individually in pens containing 3 stalls with different lying surfaces: (1) rubber mat with chopped wheat straw (WS); (2) deep-bedded switchgrass (SG); and (3) deep-bedded switchgrass, water, and lime mixture (SGL). The second objective (experiment 2) was to test, in freestall housing, the effects of these 3 types of bedding on lying behavior, cow cleanliness, and teat end bacterial contamination. Bedding treatments were compared in a 3 × 3 Latin square design using 24 cows split into groups of 8, with bedding materials being switched every 4 wk. Lying behavior was measured with data loggers in both studies. During experiment 1, cows chose to spend more time lying and had more frequent lying bouts on SG (9.4 h/d; 8.2 bouts/d) than on SGL (1.0 h/d; 0.9 bouts/d). They also spent more time standing and stood more frequently in stalls with SG (2.0 h/d; 10.1 bouts/d) than in those with SGL (0.6 h/d; 2.6 bouts/d), and stood longer in stalls with SG than with WS (0.6 h/d). In experiment 2, the total lying time, frequency of lying bouts, and mean lying bout duration were, on average, 9.7 ± 1.03 h/d, 8.2 ± 0.93 bouts/d, and 1.2 ± 0.06 h/bout, respectively, and did not differ between treatments. No treatment effects were found for cow cleanliness scores. Bedding dry matter was highest for SG (74.1%), lowest for SGL

(63.5%), and intermediate for WS (68.6%) [standard error of the mean (SEM) = 1.57%]. This may explain the higher teat end count of coliforms for cows on SGL ($0.92 \log_{10}$ cfu/g) compared with WS ($0.13 \log_{10}$ cfu/g) (SEM = $0.144 \log_{10}$ cfu/g). In conclusion, cows preferred the deep-bedded switchgrass surface over the other 2 surfaces, and deep-bedded switchgrass appears to be a suitable bedding alternative for dairy cows.

Key words: dairy cow, deep bedding, preference, switchgrass

INTRODUCTION

Bedding plays a key role in the comfort of the lying surface (Tucker et al., 2009). When offered the choice, cows have been observed to lie down more often on concrete covered with a large amount of straw than on lightly bedded soft rubber mats (Manninen et al., 2002), and spend more time lying in deep-bedded sawdust and deep-bedded sand stalls than in stalls with mattresses covered with 2 to 3 cm of sawdust (Tucker et al., 2003). Furthermore, larger amounts of sawdust bedding positively affected lying preferences of cows on geotextile mattress (Tucker and Weary, 2004). For each additional kilogram of sawdust or straw on a mattress, cows increased their daily lying time by 12 min (Tucker and Weary, 2004; Tucker et al., 2009).

In addition to being preferred by cows, deep-bedded stalls, either with sawdust or straw, have been associated with a lower incidence of and less severe hock lesions (Weary and Taszkun, 2000). Similarly, hock lesions are reported to be less frequent in cows housed on deep-bedded sand compared with cows on mattresses (Fulwider et al., 2007), and the severity of injured hocks was reported to be lower on farms using deep litter material, such as compost, sand, and horse manure, compared with farms using foam mattresses (van Gastelen et al., 2011). In a recent survey of 76 farms, the risk of hock injuries decreased with bedding at least 10 cm deep or with sand bedding (Barrientos et al., 2013).

The type of lying surface may also play an important role in cows' mammary health, by affecting cow

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cleanliness and exposure to environmental bacteria. For instance, cows had better leg and udder hygiene scores on mattresses or waterbeds than on sand (Fulwider et al., 2007), and cows on sawdust had cleaner udders than those on sand (Zdanowicz et al., 2004). More recently, however, no differences in cleanliness scores were found between cows housed on mattresses and various deep bedding materials, including sand (van Gastelen et al., 2011), or between deep-bedded straw-lime and *Miscanthus* (silvergrass)-lime (van Weyenberg et al., 2015). Bedding types also vary in their ability to support bacterial growth, with sand typically having a lower bacterial count than organic beddings (Fairchild et al., 1982; van Gastelen et al., 2011). Farms using organic bedding commonly add lime in an attempt to reduce bacterial growth (Hogan et al., 1999). Hydrated lime added to bedding has been shown to elevate pH and lower the moisture content, reducing exposure of teats to environmental mastitis pathogens for 1 d with sawdust (Hogan and Smith, 1997) and recycled manure (Hogan et al., 1999). Kristula et al. (2008) tested several bedding treatments to reduce mastitis bacterial growth and found that lime was the only treatment that significantly reduced bacterial counts.

Even though farmers are aware of the importance of bedding, the cost associated with good-quality bedding encourages them to either use less bedding or look for alternatives (van Weyenberg et al., 2015). Switchgrass (*Panicum virgatum* L.), a high-yielding, long-term perennial grass growing on marginal land (Sanderson et al., 2006), could constitute a promising bedding alternative. It is well adapted for growth under a temperate climate, is disease and pest resistant, requires low fertilizer applications, and is relatively inexpensive to grow and harvest (Frigon et al., 2012). To our knowledge, the use of switchgrass as an alternative source of bedding, either alone or in combination with lime, has not been extensively investigated in controlled studies. The first objective of this study (experiment 1) was to compare cow preference for 2 types of deep bedding materials: switchgrass and switchgrass-lime “mattress,” using straw on a rubber mat as a control. The second objective (experiment 2) was to assess the effect of these deep bedding types on lying behavior, cow cleanliness, and teat end bacterial contamination.

MATERIALS AND METHODS

Two experiments were conducted at the University of Guelph’s Alfred Campus Organic Dairy Research Farm (Alfred, ON, Canada). Animals were cared for according to the standards and guidelines of the Canadian Council on Animal Care (CCAC, 2009) and approved by the University of Guelph Animal Care Committee.

Experiment 1

Animals, Housing, and Bedding Types. Six primiparous and 3 multiparous (4 to 5 lactations) early- to late-lactation Holstein cows (mean \pm SD, BW: 683.3 \pm 100.93 kg; DIM: 13 to 436 d) were used. Before the experiment, all cows were housed in a freestall facility, on stalls bedded with sawdust over mattresses, and throughout the experiment, each cow was housed individually in a test pen consisting of 3 side-by-side wall-facing freestalls with a feed alley. Cows had been previously exposed to these pens as heifers, during the weeks before first breeding. Three similar test pens (5.03 \times 3.66 m) were used. Stalls in each pen were 1.14 m wide and 3.05 m long with a bed length of 2.53 m. The neck rail height was 1.27 m from the stall surface and no brisket board was installed. Flexible stall dividers were installed (GreenFreestall, Tags4All Global Inc., Mitchell, ON, Canada). A box made of recycled plastic lumber (252.5 \times 118 \times 14 cm) was built for each stall to accommodate the deep-bedded lying surfaces. Curb height for each stall was 14 cm. Each stall in the test pens was bedded with a different material (bedding type): (1) rubber mat (Animat rubber mats 1.9 cm thickness; Animat Inc., Saint-Élie d’Orford, QC, Canada) covered with 2 to 3 cm of chopped wheat straw (WS); (2) deep-bedded switchgrass (SG), consisting of approximately 14 cm of compacted chopped switchgrass; and (3) deep-bedded switchgrass and lime (SGL), consisting of approximately 14 cm of a compacted base mixture of switchgrass, water, and lime (CaCO₃, pH 8.0 to 9.2; Graymont, Salt Lake City, UT) in a 1:3:6 ratio based on weight, covered with 2 to 3 cm of top mixture in a ratio of 1:1:1. The floor under the rubber mat stalls was raised to ensure that the edges of the box did not extend above the bedded lying surface. Bedding types (WS, SG, and SGL) were semi-randomly allocated to the stall locations (left, middle, and right) and balanced across stall locations. Both straw and switchgrass bales were chopped using a TMR mixer (model 400 pull type; Supreme International Ltd., Wetaskiwin, AB, Canada) to a length of approximately 2 to 4 cm and 5 to 10 cm, respectively. Feces were removed and bedding was leveled to curb twice daily during morning and afternoon milkings, which started at 0530 and 1930 h, respectively. Fresh bedding material was added (WS: 2 kg; SG: 2 kg; SGL: 2.4 kg) to each stall every morning.

Preference Tests. Trios of animals (n = 9 total) were tested simultaneously, one in each test pen for 14-d periods (2 d of adaptation, 9 d of restriction, and 3 d of free choice). During the adaptation phase, cows had access to all 3 stalls. During the restriction phase, cows were sequentially provided access to only one of

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