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Effects of short-term repeated exposure to different flooring surfaces on the behavior and physiology of dairy cattle

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ABSTRACT

Dairy cattle managed in some pasture-based systems such as in New Zealand are predominantly kept outdoors all year around, but are often taken off pasture for periods of time in wet weather to avoid soil damage. It is common to keep cattle on concrete surfaces during such "stand-off" practices and we investigated whether the addition of rubber matting onto concrete areas improves the welfare of dairy cattle. Sixteen groups of 5 cows (4 groups/treatment, 5 cows/group) were allocated to 1 of 4 treatments (concrete, 12-mm-thick rubber mat, 24-mm-thick rubber mat, or deep-bedded wood chips) and kept on these surfaces for 18 h/24 h for 4 consecutive days (6 h on pasture/24 h). Each 4-d stand-off period was repeated 4 times (with 7 d of recovery between periods) to study the accumulated effects of repeated stand-off. Lying behavior was recorded continuously during the experiment. Gait score, stride length, hygiene score, live weight, and blood samples for cortisol analysis were recorded immediately before and after each stand-off period. Cows on wood chips spent the most time lying, and cows on concrete spent the least time lying compared with those on other surfaces [wood chips: 10.8 h, 24-mm rubber mat: 7.3 h, 12-mm rubber mat: 6.0 h, and concrete: 2.8 h/18 h, standard error of the difference (SED): 0.71 h]. Cows on concrete spent more time lying during the 6 h on pasture, likely compensating for the reduced lying during the stand-off period. Similarly, cows on concrete spent more time lying on pasture between stand-off periods (concrete: 12.1 h, 12-mm rubber mat: 11.1 h, 24-mm rubber mat: 11.2 h, and wood chips: 10.7 h/24 h, SED: 0.28 h). Cows on concrete had higher gait score and shorter stride length after the 4-d stand-off period compared with cows on the other surface types, suggesting a change in gait pattern caused by discomfort. Cows on rubber mats were almost 3 times dirtier than cows on concrete or wood chips. Cortisol and live weight decreased for all treatment groups during the stand-off period. We observed no major effect of the repeated stand-off exposure. In summary, adding rubber matting onto concrete surfaces for stand-off purposes is beneficial for animal welfare. A well-managed wood chip surface offered the best welfare for dairy cows removed from pasture, and the findings of this study confirm that a concrete surface decreases the welfare of cows removed from pasture.

Key words: behavior, concrete, dairy cattle, rubber mat, wood chips

INTRODUCTION

Dairy cattle spend a large proportion of their daily time resting (Singh et al., 1993; Fregonesi and Leaver, 2001; Jensen et al., 2005), and the provision of a comfortable surface to rest on is essential to maintain the health of cattle (Singh et al., 1993; Leonard et al., 1996). Cattle with reduced lying times show elevated indicators of physiological stress (Fisher et al., 2002; Tucker et al., 2007) as well as behavioral signs of frustration (Munksgaard and Simonsen, 1996; Munksgaard et al., 1999).

Lying behavior has been used as a measure of cow comfort in numerous studies investigating different surface types (Fregonesi and Leaver, 2001; Haley et al., 2000, 2001) and there is overwhelming evidence that dairy cattle prefer and spend more time lying on soft, well-bedded (Haley et al., 2000, 2001; Tucker et al., 2003, 2009; Cook et al., 2004a; Tucker and Weary, 2004; Drissler et al., 2005), and dry (Fregonesi et al., 2007; Reich et al., 2010) surfaces.

The type of lying surface strongly influences leg health (Rutherford et al., 2008; Lombard et al., 2010; Potterton et al., 2011). For example, hock health was better on deep-bedded stalls than on foam mattresses (van Gastelen et al., 2011). Indeed, leg health and lameness may be improved by the amount of bedding (Colam-Ainsworth et al., 1989) and by use of rubber mats as flooring surface instead of concrete (Leonard et al., 1994; Vanegas et al., 2006; Rushen et al., 2007).

The majority of research investigating the effects of surface types has been undertaken in systems where cat-

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tle are permanently or mostly housed indoors. In some pasture-based dairy systems, such as in New Zealand, cows are predominantly kept outdoors all year round; however, in wet weather they are sometimes removed from the pasture to a separate area to reduce soil damage. Common surfaces for these "stand-off" practices include specially constructed wood-chip pads, concrete yards, small "sacrifice" paddocks, and gravel laneways. Cows can sometimes be kept on these surfaces for up to 22 h/d for several consecutive days, depending on the weather conditions. This winter management practice could influence the health and welfare of animals. For example, Fisher et al. (2003) demonstrated that cows spent less time lying and had a greater physiological stress response when they were temporarily housed on hard surfaces and on surfaces with poor drainage compared with a well-drained wood chip surface.

In New Zealand, an increasing number of farmers are interested in adding rubber mats onto concrete yards for stand-off purposes to improve animal welfare. Although it is known that long-term exposure to hard surfaces for standing and lying causes lameness and other physical injuries (Haskell et al., 2006; Potterton et al., 2011), less is known of the effects of short-term exposure to different surface types on the behavior and physiology of cattle, and in particular any potential benefits of rubber mat surfaces compared with concrete. Therefore, the aim of this study was to investigate the behavioral and physiological effects of different types of surfaces when used in a simulated weather-induced, stand-off situation during winter in a pasture-based dairy system.

MATERIALS AND METHODS

Animals and Treatments

All procedures involving animals were approved by the Ruakura Animal Ethics Committee under the New Zealand Animal Welfare Act of 1999. Eighty pregnant, nonlactating Holstein Friesian dairy cows at the AgResearch Tokanui research farm near Hamilton, New Zealand (37°47′S, 175°19′E) were used in the study. The cows had an average BW of 488 ± 52.2 kg and BCS of 4.8 ± 0.28 at the start of the experiment and were, on average, 4.5 ± 1.70 yr of age (mean ± SD for all preceding values).

Cows were divided into 2 groups of 40 and allocated to 1 of 4 treatments (16 groups in total, n = 4 groups per treatment, 5 cows per group) consisting of 4 different surface types: (1) concrete; (2) 12-mm-thick rubber mat (Agrimat Uni, 1,190 × 850 × 12 mm interlocking mat, Numat Ltd., Auckland, New Zealand); (3) 24-mm-thick rubber mat (Agrimat Kura, 1,190 × 850 × 24 mm interlocking mat, Numat Ltd.); and (4) wood chips (approximately 0.5 m deep). Cows were habituated to their group of 40 for 5 d before the start of the experiment. The cows had no previous experience of lying down on the rubber mats (the farm was using deep-bedded wood chips as a stand-off surface). Treatment groups were balanced for BW. Eight groups of 4 cows (2 of each treatment) were tested simultaneously in 8 uncovered experimental pens (6.4 × 3.8 m, stocking density of 4.9 m^2/cow) with surface types randomly allocated to pens. The stand-off period consisted of 18 h in the treatment pens and 6 h on pasture (0900 to 1500h) per 24 h for 4 consecutive days to simulate a weather-induced stand-off period. The chosen duration of stand-off period exposure is common on New Zealand farms during winter. Following normal farm practice, no feed was available in the pens; however, water was freely available at all times from a rectangular, plastic trough (80-L capacity). The concrete and rubber surfaces were cleaned every 2 d and the wood chip surfaces refreshed (new material added) after each stand-off period. The 4-d stand-off period was followed by 7 d on pasture (recovery). These 2 periods were repeated 4 times to explore any potential accumulated effects of repeated exposure to the different surfaces, thus resulting in 44 d of data collection during June and July 2012 (Southern Hemisphere winter). A fresh sward of pasture (approximately 8 kg of DM/cow) and supplements (approximately 4 kg of DM/cow of maize, palm kernel expeller, molasses, and straw) were made available on each day at 0900 h. Behavioral and physiological measures were recorded immediately before and after each 4-d stand-off period, and weather variables were recorded continuously throughout the trial. Air temperature (°C), relative humidity (%), and rainfall (mm) were recorded at 10-min intervals using a portable weather station (Wireless Vantage Pro2 Plus, Davis Instruments, Harvard, CA) located outdoors within 5 m of the test pens. The air temperature was 8.0°C ± 2.99°C, relative humidity was 89.3% ± 7.09%, and rainfall was 6.2 mm ± 0.10 mm during the experimental period (24-h mean ± SD for all preceding values).

Lying Times, Gait Score, Stride Length, and Hygiene Score

Lying and standing times were recorded continuously using Onset Pendant G data loggers (64k, Onset Computer Corp., Bourne, MA) set to record the y- and z-axes at 30-s intervals. The data loggers were placed in a durable fabric pouch and attached on the lateral side of the hind leg above the metatarsophalangeal joint. The pouch was held in position by using Velcro patches, one sewn to the pouch and the other glued