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Investigation of dairy cattle ease of movement on new methyl methacrylate resin aggregate floorings

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ABSTRACT

Freestall dairy farms commonly present issues with cattle slips and falls caused by smooth flooring and manure slurry. This study examined the effect of 4 new methyl methacrylate (MMA) resin aggregate flooring types (1–4) compared with rubber (positive) and concrete (negative control) on dairy cow (n = 18) ease of movement when walking on straight and right-angled corridors. Our hypothesis was that cow ease of movement when walking on the MMA surfaces would be better than when walking on traction milled concrete, and at least as good as when walking on rubber. Cattle ease of movement was measured using kinematics, accelerometers, and visual observation of gait and associated behaviors. Stride length, swing time, stance time, and hoof height were obtained from kinematic evaluation. Acceleration and asymmetry of variance were measured with accelerometers. Locomotion score and behaviors associated with lameness, such as arch back, head bob, tracking up, step asymmetry, and reluctance to bear weight were visually observed. Stride length, swing time, stance time, and the number of steps taken were the only variables affected by flooring type. Differences between flooring types for these variables were tested using a generalized linear mixed model with cow as a random effect, week as a random block factor, and flooring type as a fixed effect. Multiple comparisons with a Scheffé adjustment were done to analyze differences among flooring types. Stride length was 0.14 m longer (better) on rubber when compared with concrete, and 0.11 and 0.17 m shorter on MMA 1 and 2 compared with rubber. On MMA 3 and 4, stride length did not differ from either rubber or concrete. Swing time was 0.04 s shorter (worse) on MMA 1 than on rubber, but did not differ from any other flooring. Stance time was 0.18 s longer (worse) on MMA 2 when compared with rubber, but it did not differ from any other treatment. The number of steps was higher on MMA 4 compared with rubber (4.57 vs. 3.95 steps), but did not differ from any other treatment. Of all the MMA floors tested, MMA 3 was the only one that was consistently as good as rubber (positive control). All 4 MMA floors never differed from concrete (negative control) in any of the ease of movement variables measured. These results suggest that MMA 3 may improve cow ease of movement, compared with the other MMA floors, but more research is required to confirm these findings.
Key words: flooring type, methyl methacrylate resin aggregate, ease of movement, dairy cow

INTRODUCTION

Lameness is a major concern in dairy cattle, affecting between 25 and 29% of animals in freestall facilities (Espejo et al., 2006; Ito et al., 2010). Lameness is known to be a painful condition that affects animal welfare and causes significant economic losses for producers (Warnick et al., 2001; Vermunt, 2007). It is the second most costly health condition, following mastitis (Kossaibati and Esslemont, 1997; Greenough and Weaver, 1997; Cha et al., 2010). Cows that are lame have a tendency for a reduction in milk yield (Cha et al., 2010), a lower BCS (Peake et al., 2011), and impaired reproductive abilities (Weber et al., 2013). Lameness also increases the culling rate of the herd (Enting et al., 1997), which will in turn decrease its longevity (Booth et al., 2004).

Many environmental factors can have an effect on the incidence of lameness on farms. Possible risk factors include stall comfort and dimensions (Charlton et al., 2016), bedding type (Chapinal et al., 2013a), infrequent exercise (Popescu et al., 2013), and flooring type (Cook et al., 2004; Rushen and de Passillé, 2006). Several types of flooring are available on farm, but identifying the best options may be very complex. It is important that the flooring installed brings comfort as well as traction, to ensure that it does not compromise

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cattle ease of movement or inflict hoof or limb issues (Rushen and de Passillé, 2009). The most common type of flooring found on Canadian freestall dairies is concrete (Solano et al., 2015). However, rubber has become an increasingly popular alternative over the last 20 yr (USDA, 2009).

Increasing floor friction may result in a reduction in slips and falls (Phillips and Morris, 2001). Clean and dry floors will also help reduce slipperiness and potential leg injuries resulting from falls (Phillips and Morris, 2001). Floor cleanliness is also essential to minimize claw health issues and reduce the transmission of infectious diseases (Hinterhofer et al., 2006).

Both rubber and concrete, when covered in manure slurry or not properly scraped, may become slippery, which may increase the risk of slips and falls and cause injuries (Phillips and Morris, 2001; Rushen and de Passillé, 2006). Furthermore, when the hooves of cattle are constantly exposed to moisture and manure, this causes the hooves to become soft, which may result in heel or sole crack, and further degrade into ulcers, abscesses, or other hoof infections (Ishler et al., 1999). Slippery floors may also alter cattle ease of movement (Flower et al., 2005, 2007; Flower and Weary, 2006; Flower and Weary, 2009), making it more difficult for cattle to move around within their facility (Philips et al., 2013). Kinematic variables such as stride length, swing time, stance time, and hoof height may differ when healthy or compromised cattle walk on either rubber or concrete flooring (Flower et al., 2005, 2007; Blackie et al., 2013). These measures may thus indicate whether or not a surface is adequate for cattle to walk on. Furthermore, inadequate flooring may reduce walking speed and negatively affect locomotion scores and behaviors associated with lameness (Telezhenko and Bergsten, 2005; Flower et al., 2007; Chapinal et al., 2011). Adding small particles (aggregates) that adhere to the floor surface provides animals with better traction due to an increased coefficient of friction, and can improve stride length, speed, swing time, stance time, and overall cattle locomotion (Phillips and Morris, 2001; Rushen and de Passillé, 2006). Consequently, having a flooring that provides better traction even when wet could improve cattle ease of movement, which may decrease the incidence of slips and falls hence reduce lameness cases on farms.

The purpose of the study was to investigate cattle ease of movement on 4 new types of methyl methacrylate (**MMA**) floorings to see how they would compare with a positive and a negative control flooring. Rubber was chosen as the positive control because it is a more compressible surface (Rushen and de Passillé, 2006), which brings more comfort to cattle by reducing pressure on the limbs and joints (van der Tol et al., 2005; Hernandez-Mendo et al., 2007). Concrete, on the other hand, is a harder surface with little compressibility (Rushen and de Passillé, 2006), and thus was considered as a negative control. However, depending on its finish, concrete may offer more friction than rubber, which may decrease the incidence of slips on wet flooring (Telezhenko and Bergsten, 2005). Our hypothesis was that cow ease of movement when walking on the MMA surfaces would be better than when walking on traction milled concrete as concrete is known to be a more slippery surface when wet. Yet, we hypothesize that the ease of movement of cattle walking on the MMA surface will be at least as good as when walking on rubber because the MMA surface provides more friction then rubber.

MATERIALS AND METHODS

Animals

A total of 18 Holstein cows were selected from the Organic Dairy Research Farm at the University of Guelph—Alfred Campus (Alfred, Ontario, Canada). The cows were housed in a freestall facility and were cared for according to the standards and guidelines of the Canadian Council on Animal Care (2009). The experimental protocol was approved by the University of Guelph Animal Care Committee. Only sound and healthy animals were enrolled in the study. The 2 most recent hoof trimming reports (2 and 9 mo before the study) were consulted to select cows without any hoof disease or hoof injury, and a visual gait scoring was done by one trained observer while cows were walking on a sand path to ensure none were clinically lame [none with a numerical rating system (**NRS**) $\geq$4 as described by Flower and Weary (2006)]. The selected cows had a parity range of 1 to 6 (parity 1: n = 6 cows; parity 2: n = 5; parity 3: n = 3; parity $\geq$4: n = 4) to maximize the chance that cows had different gait scores because parity influences gait as observed by Chapinal et al. (2009). The experimental cows were all $\geq$122 DIM (mid lactation: 122–198 DIM, n = 6 cows; late lactation: 208–291 DIM, n = 7; and dry $\geq$305 DIM n = 5) at the beginning of the trial.

Flooring Types

Two control flooring types, rubber mats, 1.9 cm thick (Animat Inc., Saint-Élie d'Orford, QC, Canada), and traction milled concrete (Agri-Trac, Woodstock, ON, Canada) were chosen, as they are the common types of flooring found in dairies in North America (concrete found mostly in parlors at 67%, holding pens at 65%, and rubber found in parlors at 33%, holding pens at