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Dairy calves' preference for rearing substrate

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ABSTRACT

Traditional substrate types for dairy calves, such as sawdust, are becoming difficult and/or expensive for farmers to obtain in New Zealand. Therefore, there is a need to evaluate alternative rearing substrates that provide an acceptable level of animal welfare. The preference of dairy calves for four different rearing substrates was evaluated (traditional and novel). At 1 wk of age, 24 calves were housed in groups of four, in pens which were evenly divided into four rearing substrates: sawdust, rubber, sand and stones. During the first 3 d calves were given free access to all four substrates. Calves were then restricted to each substrate type for 48 h. In order to rank preference, calves were subsequently exposed to two surfaces simultaneously in a pairwise manner for 48 h until all animals had experienced all six treatment combinations. Finally, calves were again given free access to all four substrates simultaneously for 48 h. Lying behaviour and location in the pen was recorded for the final 24 h during the free-choice and pairwise periods using video recorders and accelerometers. During the restriction period, lying behaviour was recorded for the final 24 h using accelerometers and play behaviour was recorded over 12 h using video recorders. Calves were blood sampled during the restriction period to measure cortisol, glucose and lactate concentrations, and white blood cell numbers. Preference was determined based on time spent lying on each substrate. During the initial free-choice period, calves spent more time lying on sawdust (76.6%, S.E.M.: 0.90%) than all other substrates (rubber: 1.6%, sand: 0.9% and stones: 0.5%, S.E.M.: 0.90%). When restricted to each substrate, calves spent more time running on sawdust (2.5 min/12 h, S.E.M.: 0.37 min), rubber (2.1 min/12 h, S.E.M.: 0.37 min) and sand (1.7 min/12 h, S.E.M.: 0.37 min) than on stones (0.9 min/12 h, S.E.M.: 0.37 min). In addition, calves spent more time lying on sawdust (17.8 h/24 h, S.E.M.: 0.38 h) and rubber (17.2 h/24 h, S.E.M.: 0.38 h) in comparison to sand (16.0 h/24 h, S.E.M.: 0.38 h) and stones (16.3 h/24 h, S.E.M.: 0.38 h). The order of preference of the rearing surfaces was sawdust > rubber > sand > stones. At the end of the study, when given free access to all rearing substrates again, calves spent a higher proportion of time lying on sawdust than all other substrates. Blood chemistry and haematology measures of calves were similar when restricted to each substrate type. In conclusion, dairy calves showed a clear preference for sawdust over rubber, sand and stones. The calves' preference for sawdust may be associated with the physical and thermal properties in comparison to the alternative substrates.

1. Introduction

Good management of dairy calves during the pre-weaning period is essential to reduce stress and the risk of disease (Panivivat et al., 2004; Sutherland et al., 2013). The rearing substrate is an important aspect of calf management as it can influence the behaviour, physiology and health of calves (Hill et al., 2011; Panivivat et al., 2004; Sutherland et al., 2013). Several surfaces for rearing calves have been investigated, including concrete (Camiloti et al., 2012), rice hulls, wheat straw, wood shavings, granite fines (Panivivat et al., 2004) and stones (Sutherland et al., 2013). Calves showed an aversion to lying on bare concrete when given the choice of sawdust as a rearing substrate (Camiloti et al., 2012). More calves were treated for scours when reared on granite fines than wood shavings (Panivivat et al., 2004) and calves reared on stones had lower skin temperature and spent less time lying and playing than calves reared on sawdust (Sutherland et al., 2013). Organic

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materials such as straw, sawdust and wood shavings are commonly used as rearing substrates for dairy calves in New Zealand, however, there is a recent trend to move away from such materials, due to hygiene concerns, lack of availability, and labour and transportation costs, which affect the total on-farm price and use (Kartal and Yanar, 2011; Panivivat et al., 2004). Therefore, there is a need to evaluate alternative rearing substrates for dairy calves that are economically viable for farmers, readily available and provide an acceptable level of animal welfare.

Dairy calves spend up to 80% of the day lying down (Panivivat et al., 2004; Sutherland et al., 2013) and lying behaviour has been used in previous studies to assess calf comfort on different surface types (Camiloti et al., 2012; Sutherland et al., 2013). Furthermore, Hänninen et al. (2005) found that reduced lying time was associated with reduced growth in calves. Dairy cow preference, determined by lying times, has been used to evaluate different flooring surfaces for dairy cows in free-stall systems (Fregonesi et al., 2007; Norring et al., 2008; Tucker et al., 2003). Preference testing is a simple way to assess how an animal perceives its environment (Rushen et al., 2008) and can be used to evaluate the choices animals make between resources (Kirkden and Pajor, 2006). How animals perceive the substrates they are housed on has been used to develop recommendations for improved comfort and more efficient management techniques for dairy cows, lambs, sheep and goats (Bøe et al., 2007; Færevik et al., 2005; Teixeira et al., 2013; Tucker et al., 2003). However, little is known about dairy calf preference for novel surfaces such as stones, sand or rubber chips.

Although preference tests help us understand if an animal prefers one environment over another, they do not indicate whether the animal likes or dislikes both environments or that the animal is suffering in the environment that is least preferred (Dawkins, 1977). Incorporating information on an animal's physiological response to the environment could assist in the interpretation of anomalous choices. Animals unable to express and perform actions that they are motivated to do, due to restrictions within the environment, can result in impaired health, survival and productivity (Fraser et al., 1997). An aversive environment may prompt a stress response as a means for the animal to cope with or avoid potentially harmful situations. For example, lying deprivation caused an increase in basal cortisol levels in cattle (Fisher et al., 2002) and negative environmental choices were asssociated with higher blood glucose conentrations in laying hens (Nicol et al., 2009).

Play behaviour has been suggested as an indicator of positive emotions and welfare (reviewed by Boissy et al., 2007). Young animals are highly motivated to play when all their basic needs, such as health and thermal comfort, are met (Jensen et al., 1998). The expression of play behaviour in calves is reduced after a negative experience, such as weaning (Krachun et al., 2010) or disbudding (Mintline et al., 2013), or when housed on an uncomfortable surface (Sutherland et al., 2013). Therefore, investigating play behaviour in addition to lying times and physiological parameters may provide a more comprehensive assessment of the welfare of calves reared on different surfaces.

The objectives of this study were to: (1) investigate the preference of dairy calves for different rearing substrates (rubber chip, sand, sawdust or stones), and (2) investigate the effect of rearing substrate on the behaviour and physiology of calves. Stones and sawdust were chosen as substrates for this study due to their current use on-farm. Sand is commonly used as a lying surface for adult dairy cattle in free-stall systems and rubber chips were selected because they are a novel alternative commonly used for horse arenas. It was predicted that calves presented with a choice would spend more time and have increased occurrences of play behaviour on substrates which were softer and had greater insulation properties, and would have increased concentrations of physiological indicators of stress such as cortisol when restricted to less preferred substrates.

2. Materials and methods

2.1. Animals and husbandry

All procedures involving animals were approved by the AgResearch Ruakura (Protocol N° 12966) and University of Waikato Animal Ethics Committees (Protocol N° 897) under the New Zealand Animal Welfare act 1999. The study was conducted between July and September (southern hemisphere winter) 2013 at the AgResearch Ruakura research farm, Hamilton (latitude 37°47′ S, longitude 175°19′ E), New Zealand.

Twenty-four Friesian-cross dairy heifer calves were used in the study. Eight calves were sourced from a commercial farmer located within the Waikato region. The remaining 16 calves were sourced from the AgResearch dairy research farm, South Waikato, New Zealand. The calves were separated from their dams within 24 h of birth and transported to the farm's calf rearing facility. Calves were group housed and kept in pens with floors covered in woodchip (*Pinus radiata*, 15–30 mm in length) prior to being transported to the study site at approximately 5 d of age (range 3–8 d). Calves arrived at the study site in groups of eight animals over a 2 mo period, this staggered arrival allowed time to perform all treatments at the same age. Calves were transferred straight into the free-choice pen (below).

On arrival at the study site, calves were weighed and assigned to a replicate group. To distinguish between individuals for video observations, calves were given different coloured collars, ear tagged and individually marked with animal paint (Tell-tail paint, FIL New Zealand, Mount Maunganui, New Zealand) across the back.

Calves were individually fed 2.5 L of colostrum twice a day at 08:00 and 15:30 h for the first 4 d after birth. Thereafter, the equivalent amount of milk replacement was offered (Ancalf, Fonterra LTD, Auckland, New Zealand) using a round 20 teat (1100 mm diameter × 860 mm depth) milk feeder (Stallion Plastic Ltd, Palmerston North, New Zealand). The feeder was removed after each feeding. Additionally, calves were given ad libitum access to meal (NRM Moozlee, Auckland, New Zealand) consisting of 18% crude protein, 10% crude fibre and 5% crude fat. Water was provided ad libitum.

2.2. Experimental design

At approximately 5 d of age, calves (mean body weight: 34.9 kg, range: 22.5–47.0 kg) were allocated to one of the six groups (four calves per group) balanced for age and body weight and then moved into the free-choice pens. The study was replicated six times with each replicate comprising of one group of four calves. All fours calves per replicate were tested simultaneously. At the start of the experimental period calves were approximately 8 d of age; average age of calves for each replicate ranged from 6.5 to 9.8 d of age. The study consisted of four consecutive testing periods: (1) an initial free-choice, (2) restriction, (3) pairwise choice and (4) a final free-choice period. Measures taken during each test period are summarised in Table 1.

During the first free-choice period all four calves in a group had access to all four substrates for 5 d:3 d to acclimate to the facilities and explore the substrates and the following 2 d were the start of the experimental period. During the restriction period, calves were allowed access to only a single substrate at a time, each for