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Rearing substrate and space allowance influences locomotor play behaviour of dairy calves in an arena test

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ABSTRACT

The aim of this study was to investigate the effect of rearing substrate and space allowance in the home environment on the motivation of dairy calves to perform locomotor play in an arena test. At 1 wk of age, 72 calves were moved into one of 18 experimental pens ($n = 4$ calves/pen) where they remained until 6 wk of age. Half of the pens had floors covered with stones (ST) and the other half were covered with sawdust (SD). For each substrate type, calves were reared at one of three space allowances: 1.0, 1.5 or 2.0 m^2/calf. Behaviour was video recorded continuously for 24 h in the home environment at 4 and 6 wk of age. Calves were tested individually in an arena test at 3 and 6 wk of age, where behaviour was recorded for 20 min. The arena floor was covered in wood chip. Running duration and the frequency of running, jumping, kicking and bucking were scored continuously and used as measures of locomotor play. At 4 and 6 wk of age in the home environment, calves reared on ST spent less ($P < 0.05$) time walking than calves reared on SD and calves reared at 1.0 m^2/calf spent less time ($P < 0.05$) walking than calves reared at 1.5 or 2.0 m^2/calf. However, substrate type and space allowance did not affect ($P > 0.05$) time calves spent running in the home environment. In the test arena, calves reared on ST ran more at 3 (1.7 and 1.5 ± 0.05 square-root transformed values, ST and SD respectively, $P = 0.001$) and 6 (1.4 and 1.2 ± 0.08 square-root transformed values, ST and SD respectively, $P = 0.035$) wk of age than calves reared on SD. At 3 wk of age, calves reared at 1.0 m^2/calf spent more ($P = 0.016$) time running than calves reared at 2.0 m^2/calf (1.7, 1.6 and 1.5 ± 0.06 square-root transformed values, 1.0, 1.5 and 2.0 m^2/calf respectively, $P = 0.022$) in the test arena. Furthermore, time spent running in the home pen was positively correlated with running duration in the arena test irrespective of substrate type (ST: $r = 0.35$, $P = 0.003$ and SD: $r = 0.32$, $P = 0.008$) and space allowance (1.0 m^2/calf: $r = 0.42$, $P = 0.004$; 1.5 m^2/calf: $r = 0.28$, $P = 0.054$; 2.0 m^2/calf: $r = 0.25$, $P = 0.095$). Overall, our results suggest that different housing conditions (rearing substrate and space allowance) can affect the motivation of calves to perform locomotor play in an arena test, however the stimuli associated with this increased motivation to play remains unclear.

1. Introduction

Good management of the pre-weaning rearing environment of dairy calves is essential for good welfare and include factors such as rearing substrate and space allowance. Traditional substrate types, such as sawdust and

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wood shavings, are becoming difficult and/or expensive for farmers to obtain in New Zealand and some other countries. The use of stones as a substrate for rearing dairy calves is becoming more common in New Zealand because of cost, availability and perceived health benefits for calves. The stones used for calf rearing are of the type commonly used for decorative purposes in gardens, ponds or for drainage. A preliminary study failed to show any health benefits associated with rearing calves on stones and a reduction in lying and the performance of locomotor play on stones in the home environment was reported (Sutherland et al., 2013). In New Zealand there are no requirements or guidelines on space allowances for rearing calves, but the industry standard is approximately 1.0 m^2/calf and an allowance of 1.5 m^2/calf is recommended (On-Farm Research, 2013). The European Union legislation states a minimum space requirement of 1.5 m^2/calf (Jensen and Kyhn, 2000). Space allowance during the pre-weaning rearing period has been shown to influence growth and behaviour, including locomotor play in dairy calves (Færevik et al., 2008; Jensen et al., 1998; Tapkı et al., 2006). Therefore, there is a need for further scientific investigation into the welfare implications of rearing calves on stones or at a space allowance of 1.0 m^2/calf if these practices are to be fully evaluated.

Play has been identified as a potential indicator of animal welfare as it is associated with positive experiences and is reduced during challenging conditions (Held and Špinka, 2011). An arena test is a potential way to assess play and how different housing conditions effect the motivation of calves to perform locomotor play (Jensen and Kyhn, 2000; Mintline et al., 2012). Increased performance of a particular behaviour (an activity rebound) after a period of restriction may indicate a build-up of internal motivation to perform that behaviour during the period of restriction (Dellmeier et al., 1990; Jensen, 1999; Nicol, 1987). Indeed, confinement reduced locomotor play in individually and group housed calves in the home environment, but increased the motivation of calves to perform locomotor play in an open-field test that provided greater space to move (Dellmeier et al., 1990; Jensen, 1999; Jensen and Kyhn, 2000). Calves reared on stones spent less time performing locomotor play and performed a less complex repertoire of play behaviours in the home environment than calves reared on sawdust (Sutherland et al., 2013). The ability of calves to perform locomotor play on stones may have been restricted due to the characteristics of the stones (*e.g.* hardness and/or instability). Therefore, it would be important to know whether calves reared on stones are more motivated to perform locomotor play when released into an arena test, and whether space allowances relevant to New Zealand conditions affect the motivation of calves to perform locomotor play in an arena test.

The purpose of this study was to investigate the effect of rearing substrate and space allowance on the motivation of dairy calves to perform locomotor play behaviours in an arena test. It was predicted that rearing calves at smaller space allowances and on stones would reduce the amount of locomotor play performed in the home environment and hence increase their motivation to perform locomotor play in an arena test.

2. Materials and methods

2.1. Animals, housing and feeding

This study was conducted between July and September (Southern hemisphere winter) 2012 at the AgResearch dairy research farm, South Waikato (175° 18 00′ E longitude, −38° 03 00′ S latitude), New Zealand. All procedures involving animals were approved by the AgResearch Ruakura Animal Ethics Committee under the New Zealand Animal Welfare act 1999.

Seventy-two Friesian-cross dairy heifer calves were used in the study over three repetitions. The calves were separated from their dams within 24 h of birth and transported to the farm's calf rearing facility. The calf rearing facility had solid dirt floors and walls on all four sides. The walls were either solid or covered with shade cloth (Donaghys Industries Ltd., Christchurch, New Zealand) to reduce exposure from the wind. Calves were kept in group pens (15 calves per pen, 3 m × 6 m) with floors covered with wood chip (*Pinus radiata*, 15–30 mm in length) prior to being moved to experimental pens at approximately 6 d of age. Experimental pens were located in the middle of the facility and were separated by wooden panel fences that allowed auditory, visual, olfactory and some tactile contact between animals in adjacent pens. All experimental pens had plastic troughs for water (350 mm width × 300 mm length × 200 mm depth) and feed (310 mm width × 770 mm length × 260 mm depth) and these were attached to the side of the pen. Half of the pens were covered with stones (ST, Mangatangi River Rock Ltd, Auckland, New Zealand, www.mrrl.co.nz) with an approximate diameter of 40–60 mm and the other half were covered with sawdust (SD) with an average particle size of 10 mm. Rearing substrates were laid over dirt floors at a depth of approximately 30 cm. The stones and sawdust had not been used prior to the start of the study. Sawdust pens were topped up with dry clean sawdust when pens became damp following the normal operating procedure at the farm, however, stones were not cleaned during the experimental period.

Calves were individually fed 2 L of colostrum twice a day at 08:00 and 16:30 h for the first 4 d after birth. Thereafter, the equivalent amount of milk replacement was offered (SupaCalf™, Fonterra Ltd., Auckland, New Zealand) using a five-teat milk feeder (Calfateria series, FC5, Stallion Plastic Ltd., Palmerston North, New Zealand) which was removed after each feeding. Additionally, calves were given *ad libitum* access to a mixed feed of FibreStart (Fibre Fresh Feeds, Reporoa, New Zealand) consisting of 20% crude protein, 4% crude fat and 25% crude fibre, and TOPCALF Formula 20 (Inghams Feed & Nutrition, Hamilton, New Zealand) consisting of 20% crude protein, 5% crude fat and 7% crude fibre. Water was provided *ad libitum*.

2.2. Experimental design

At 6 d of age (±3 d), 72 calves (38.4 ± 0.84 kg) were allocated to one of six treatments (calves reared on ST or SD at a space allowance of 1.0, 1.5 or 2.0 m^2/calf; $n = 12$ calves per treatment) and then moved into one of 18