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Preference in shorn sheep for different types of slatted flooring at low ambient temperatures

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ABSTRACT

The aim of this study was to investigate the preference of ewes for different floor materials at low ambient temperatures. A total of 30 non-pregnant ewes were sheared and allocated to one of ten stable groups with three animals per group. Ten pens were constructed with two different floor materials and ewes could eat and drink through a continuous feed opening on both floor materials. Groups were habituated to all floor material combinations and systematically rotated through the ten pens. Behaviours standing/walking; resting and eating/drinking were scored from 20 h video recordings using instantaneous sampling in 10 min intervals. Location in the pen (section A or B) and physical contact during resting was also recorded. Sheared ewes showed clear preferences for standing/walking ($F_{4,80} = 14.6$, $P < 0.0001$) and resting ($F_{4,80} = 34.8$; $P < 0.0001$) on solid floor materials than on slatted floors. Sheep tended to spend a larger proportion of time resting on solid rubber than solid wood in pen 10 (Fig. 3; $T = 2.26$; $P = 0.09$). Between the different slatted floor materials we found no significant difference in behaviour parameters. Floor material *per se* and temperature category interacted significantly for the behaviour standing/walking ($F_{16,80} = 2.42$; $P = 0.005$). Heat conductivity properties were very different between floor materials and the largest temperature drop was observed on solid rubber mat (8.4 °C), while the smallest temperature drop was evident on a layer of straw (3.1 °C). In conclusion, there are other properties than heat conductivity of the materials that influence sheared ewes' preference for floor materials in low ambient temperatures.

1. Introduction

In conventional sheep housing in Norway the animal welfare regulations allow fully slatted floor pens, and in fact the vast majority of Norwegian sheep barns are built with slatted flooring in the entire pen area (Simensen et al., 2014). In Sweden, slatted flooring in the lying area will be prohibited from 2017 and the EU regulations for organic sheep farming demand that half of the 1.5 m^2 total area per ewe should be a resting area with solid flooring (Djurskyddsförordningen, 1988).

The main concern regarding slatted flooring systems is the heat loss to the floor at low temperatures when lying, the lying comfort *per se* and the lack of ability to add bedding material. Previous studies have shown that both goats (Andersen and Boe, 2007) and ewes (Boe et al., 2006) prefer a lying area with solid flooring. Interestingly, ewes with a full coat of wool distinguish very little between slatted floor alternatives and solid floors for resting at low temperatures (Faerevik et al., 2005), but when the same ewes were sheared, solid wood or straw was preferred over expanded metal flooring. Furthermore, straw was preferred over solid wood. Solid flooring in the resting area for sheep may be a challenge for keeping the wool clean and the claws healthy. Previous experience from sheep (Jorgensen and Boe, 2009) implies that a solid resting area must be cleaned once or twice daily.

In later years, slatted floors made of materials like fibre composite and plastic (e.g. Stefanowska et al., 2002) have been introduced also for small ruminants. These modern floor types are claimed to have low heat conductivity and hence "better" for the sheep, but the actual preference in sheep has not been tested.

The aim of this study was investigate the preference in ewes for different types of solid and slatted flooring at low ambient temperatures.

We hypothesized that:

H1. Sheared sheep will prefer distinct floor materials for resting over others, at low ambient temperatures. From this we predicted that sheep will spend more time resting on floor materials like fibre composite and plastic slatted floors compared to expanded metal floors.

H2. The five different floor materials will have very different

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conductivity properties. From this we predicted that fibre composite materials and plastic slatted floors will have lower heat conductivity than expanded metal floors.

2. Materials and methods

A controlled preference test was conducted in January 2016 at Tjøtta experimental station in the northern part of Norway using 10 groups of three ewes rotating through 10 experimental pens with different pairwise combinations of five floor types. The experiment did not involve procedures that demanded a central approval from the Norwegian committee for research animals (FDU), but the committee was informed and the welfare and safety of the animals was ensured through the local head of animal welfare, connected to the approved research facility.

2.1. Experimental design and pens

The experiment was performed in a non-insulated building and during the experimental period in January the indoor air temperature varied from −11.8 to + 3 °C. Each experimental pen measured 3.0 × 2.0 m (total 6.0 m^2) and were divided into two equal sections (A and B) of 3.0 m^2 (Fig. 1). Hence, the space was sufficient so that all three ewes could be lying and feeding simultaneously in each section of the pen.

Five different floor types; expanded metal, slatted floor made of fibre composite, slatted floor made of plastic, solid floor made of wood and solid floor consisting of a rubber mat used for dairy cows, was used in this study (Table 1). The pen floor was cleaned both before the morning and afternoon feeding, and in addition a thin layer of sawdust (approximately 0.5 cm thick) was provided on the solid floor sections to ensure a dry and non-slippery surface.

The ten individual combinations of five different floor materials were installed in section A and B in the ten experimental pens as described in Table 2.

In order to habituate the ewes to the different experimental pens, groups were randomly allocated to one of 10 experimental groups on November 26th and systematically rotated through all the 10 experimental pens every second day, leaving two days to all possible pairwise combinations of the five floor materials. After the habituation period, the ewes were kept in a large group on deep straw bedding in order to reduce the work load during the Christmas holidays.

The experiment started on January 6th and the ewes were weighed, marked with their group number across their backs and placed in the same experimental groups as before. Similar to the habituation period, the 10 groups were systematically rotated between all the 10 experimental pens every second day, providing an experimental period of 48 h per pen.

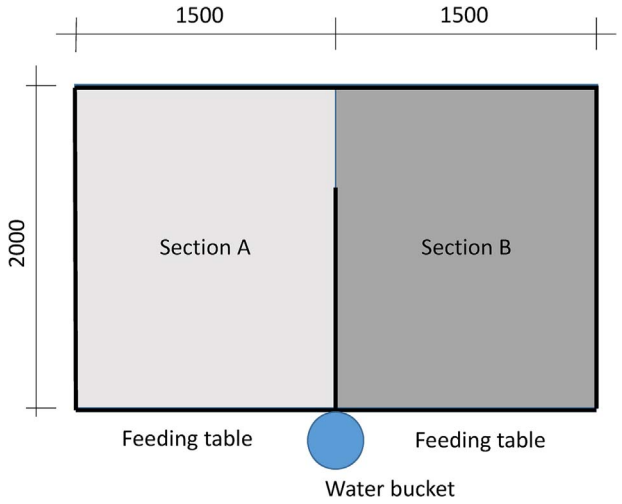


Fig. 1. Experimental pen with measures in mm.

Table 1
Description of different materials used as floors in the study.

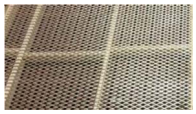
Floor material number	Illustration	Product name and description	Manufacturer
1		Expanded steel metal elements. Slat opening 1.7 cm	Brødrene Midthaug AS, Norway
2		Fiber composite slatted floor (Longvik). Width of slats: 2.5 cm, slat opening 1.8 cm	Wee Marine AS Norway
3		Plastic slatted floor elements (MIK stepper). Slat opening 1.4 cm	MIK International
4		Solid wooden floors	Local wood store (spruce)
5		Rubber mats (resting matresses for cattle)	Kraiburg

Table 2
Experimental pens and floor materials in the two different pen sections.

	Floor combination	
Pen	Section A	Section B
1	Expanded metal	Fibre composite
2	Plastic slats	Expanded metal
3	Plastic slats	Solid wood[a]
4	Fibre composite	Solid wood[a]
5	Fibre composite	Solid rubber mat[a]
6	Plastic slats	Fibre composite
7	Plastic slats	Solid rubber mat[a]
8	Solid rubber mat[a]	Expanded metal
9	Expanded metal	Solid wood[a]
10	Solid rubber mat[a]	Solid wood[a]

[a] All solid floor materials were covered with a thin layer of sawdust (0.5 cm thick).

2.2. Animals and feeding

A total of 30, eight to nine months old, non-mated ewes of the Norwegian White crossbreed were randomly selected from the experimental sheep farm for this study. The ewes were sheared November 25th. The body weight at the start of the experiment was 40.8 ± 3.8 kg and the length of the wool was 1.8 ± 0.2 cm (based on data from 13 randomly chosen ewes). Animals were fed grass silage *ad libitum* and 300 gr/animal of a standard concentrate feed (Formel Sau, Felleskjopet) in the morning (08:00) and in the afternoon (15:00). Drinking water was provided from buckets located outside the feed barrier and standard salt stones for sheep were hung up on the pen walls.

2.3. Behavioural observations

The ewes were video recorded for the last 24 h of each experimental period using cable connected colour video cameras suspended over