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Radiant heat increases piglets' use of the heated creep area on the critical days after birth

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Abstract

The aim of the present study was to investigate how piglets' use of a creep area is affected by using radiant heat compared to an incandescent light bulb. It was hypothesised that radiant heat would increase the use of the creep area. Twenty litters were randomly assigned to one of two heat sources in the creep area: (1) an incandescent light bulb (STANDARD, n=10) or (2) a radiant heat source (RADIANT, n=10) with five of each type of heat source in each of two batches. Observations on piglets' position in the pen were made by scan sampling every ten minutes in a 4-hour period from 1100-1500 h on day 1 to 7, 14 and 21 *post partum*. A higher percentage of piglets in the creep area was seen for RADIANT litters compared to STANDARD litters on day 2 ($P=0.002$) and day 3 ($P=0.005$), and percentage of piglets in the creep area increased for RADIANT litters from day 1 to 2 ($P<0.001$) and from day 2 to 3 ($P=0.03$) while it first increased for STANDARD litters from day 2 to 3 ($P=0.01$). In conclusion, radiant heat gave an earlier and increased use of the creep area on the critical days after birth.

Keywords: Behaviour; Piglet; Thermal environment; Heat source; Use of creep area

Introduction

High mortality rates among neonatal piglets are considered one of the major problems in modern pig production. A heated creep area positioned in one corner of the pen is considered a safe hideout away from the sow and a way to comply with the thermal needs of the neonatal piglet without compromising the sow's thermal upper limits. Many attempts have been made to increase piglets' early use of the creep area, though not successfully (e.g. Lay et al., 1999; Vasdal et al., 2010; Zhang and Xin, 2001). In this study we aimed to try a new approach to reach this goal by comparing the normally used incandescent light bulb to a newly invented radiant heat source. The incandescent light bulb has been shown to supply a concentrated amount of heat just under the bulb. Such heating results in a centre too hot and a periphery too cold with the consequence that most piglets within a litter will not experience the optimal temperature when lying in the creep area (Zhang and Xin, 2001). The result may be that piglets choose the natural thermal solution and stay close to the sow. Radiant heat provides a more even and widespread heat surface, and it creates a heat carpet in front of the creep area, thereby decreasing draft. In addition, this particular radiant heat source also regulates the temperature within the creep area both according to ambient temperature and age of the piglets. This is done by automatically turning off the heat source when the set-point temperature is achieved and by lowering the set-point temperature with days *post partum*. The aim of the present study was to investigate how piglets' use of the creep area is affected by installing a radiant heat source in the creep area in comparison to the incandescent light bulb. It was hypothesised that the radiant heat source would increase the use of the creep area. Due to the small-scale of the study, production parameters such as mortality and weight gain are not included in this study.

Materials and methods

Animals, housing and management

The experimental animals were 20 litters from third parity sows (Danish Yorkshire x Danish Landrace), all inseminated with Duroc semen. A maximum of 14 piglets per litter were used, and excessive piglets were cross fostered to sows not included in the experiment within 24 hours after ended farrowing. The experiment was conducted at Research Centre Foulum, Aarhus University, Denmark, in two batches running from November to December 2013 and May to June 2015. Litters were housed in the same climate-controlled farrowing room in both batches, with 10 farrowing crates in the room. Farrowing crates were 4.8 m² in size with 2.1 m² of slatted floor and a 0.6 m² creep area (see Figure 1). Creep areas were placed in the right or left front corner of the pen and had a cover, a heat source and a 2.5 cm thick rubber mat as surface ground. The room temperature was kept at 20 °C throughout the experiment. From day 115 of gestation of the first expected farrowing and until the last farrowing, the light was turned on 24 hours a day; this was necessary to monitor the farrowing. Thereafter, the light followed a 12-hour cycle and was on from 0600-1800 h. The room had a small window bringing in natural daylight. On the first day after farrowing, the piglets were numbered with earmarks and within 4 days after farrowing, all piglets were tail docked and the males were castrated. On day 1 to 7, 14 and 21, all piglets were weighed and their rectal temperature measured from 0830-1030 h (results not presented here). Batch 1 was part of a larger study which involved measurements on the sow on the same days, including measurement of sows' rectal temperature (Muns et al., 2016) and surface temperature using an infrared camera.

Experimental protocol and data collection

The litters experienced one of two heat sources in the creep area: either an incandescent light bulb (**STANDARD**, n=10) or a radiant heat source, eHeat (**RADIANT**, n=10, Animal Care ApS), with five of each heat source within each batch. The placement of the two heat sources was switched between the two batches (see Figure 1). Both heat sources were turned on the day before farrowing and turned off at day 10 after farrowing. The incandescent light bulb emitted a constant amount of heat in the creep area during the 10 days, while the radiant heat source turned down the set point temperature with 0.8 °C per day from 28 °C to 20 °C. The light source in the incandescent light bulb was 100 W while no light was used in the radiant heat source.

Behaviour observations were performed on day 1 to 7, 14 and 21 *post partum*. For a 4-hour period from 1100-1500 h, piglets' position in the pen was recorded by scan sampling every 10 minutes. Piglets could have one of three positions as defined in Table 1.

Statistical analysis

All statistical analyses were performed in SAS 9.4 (SAS Inst., Inc., Cary, NC). The response variables analysed was percentage of piglets in the creep area and percentage of piglets at the sow's udder. Each response variable was calculated as an average of each experimental day (day 1 to 7, 14, and 21). Both were analysed using Proc MIXED (Littell et al., 1996), with heat source, day *post partum*, the interaction between the two and batch as fixed effects, litter size at single experimental days and average birth weight in the litter as covariates, litter as a random effect, and covariance structure modelled as compound-symmetry. Results are presented as least square means $\pm$ SEM.

Results

Percentage of piglets in the creep area was affected by type of heat source and day *post partum*, seen by an interaction between the two variables ($F_{8,144}=2.12$, $P=0.04$). No difference between the two heat sources was seen on day 1 *post partum*, but the percentage of piglets in the creep area was higher for RADIANT litters compared to STANDARD litters on day 2 ($P=0.002$) and day 3 ($P=0.005$; see Figure 2). For RADIANT litters, the percentage of piglets in the creep area significantly increased from day 1 to 2 ($P<0.001$) and from day 2 to 3 ($P=0.03$). For STANDARD litters, the percentage of piglets in the creep area did not increase significantly from day 1 to 2 ($P=0.12$), but did increase it from day 2 to 3 ($P=0.01$) and from day 3 to 5 ($P=0.003$).

The percentage of piglets at the sow's udder was also affected by type of heat source and day *post partum*, seen by an interaction between the two variables ($F_{8,144}=1.97$, $P=0.05$). No difference between the two heat sources was seen on day 1 *post partum*, but RADIANT litters had a lower percentage of piglets at the sow's udder compared to STANDARD litters on day 2 ($P=0.009$) and day 3 ($P=0.006$; see Figure 3). For RADIANT litters, the percentage of piglets at the sow's udder significantly decreased from day 1 to 2 ($P<0.001$) and from day 2 to 3 ($P=0.02$). The same pattern was seen for STANDARD litters for which the percentage of piglets at the sow's udder decreased from day 1 to 2 ($P=0.03$), day 2 to 3 ($P=0.03$), day 3 to 5 ($P=0.02$) and day 4 to 6 ($P=0.04$).

Discussion

As previously shown, piglets' use of the creep area increased with days *post partum* (Larsen and Pedersen, 2015; Pedersen et al., 2007; Vasdal et al., 2010) and time spent at the sow's udder decreased with days *post partum* (Houbak et al., 2006; Hrupka et al., 1998; Pedersen et

al., 2007). In addition to former research, the current study provides results for piglets' use of the pen until day 21 *post partum*.

Type of heat source affected both the percentage of piglets in the creep area and at the sow's udder. The percentage of piglets in the creep area increased earlier for litters experiencing radiant heat than for litters experiencing the incandescent light bulb. Further, litters experiencing radiant heat had a higher percentage of piglets in the creep area on day 2 and day 3 *post partum* and had a lower percentage of piglets at the sow's udder on the same days.

The first 3 days after birth are considered the most critical days in the piglet's life with the main proportion of piglet deaths happening during these days (e.g. Kilbride et al., 2012; Pedersen et al., 2011). Furthermore, crushing of piglets by the sow is the cause most often observed (e.g. Edwards, 2002; Kilbride et al., 2012; Pedersen et al., 2011) while underlying causes include starvation and hypothermia (English and Morrison, 1984). According to the results obtained in the present study, radiant heat ensured a higher use of the creep area these critical days and might, therefore, decrease piglet mortality due to crushing and hypothermia. Further, radiant heat has in previous studies been proved effective in reducing hypothermia in new-born piglets (Andersen and Pedersen, 2015; Pedersen et al., 2016). Radiant heat also resulted in a lower percentage of piglets at the sow's udder these critical days which could increase mortality due to starvation. However, radiant heat did not affect the percentage of piglets' at the sow's udder on day 1 *post partum* and did, therefore, not conflict with piglets' intake of colostrum. As explained earlier, radiant heat provides a more even and widespread heat surface, decreases draft in the creep area, and this particular radiant heat source could, in addition, regulate the temperature within the creep area, both according to ambient temperature and age of the piglets. According to the present results, one of these qualities could be important in increasing piglets' use of the creep area, but

further investigation is needed to conclude on which one. Another difference between the two heat sources is the presence of light in the creep area which is essential for the incandescent light bulb and non-existing with the radiant heat source. It could be hypothesised that the light would help the piglets to find the creep area. However, this could not be confirmed in a study by Larsen and Pedersen (2015). Instead they found that the lack of light during darkness increased the use of the creep area. With the above mentioned qualities, a radiant heat source would not only be expected to give an earlier and higher use of the creep area but also increase the thermal comfort of piglets when lying in the creep area. Lying postures have previously been documented to be piglets' primary thermoregulatory strategy (Kammersgaard, 2013; Vasdal et al., 2009). Therefore, it could be interesting to compare piglets' lying postures in creep areas with the two types of heat sources to investigate whether a radiant heat source also increases piglets' thermal comfort and thereby the welfare of piglets during lactation. Further, to replace the incandescent light bulb with a radiant heat source it is important to investigate whether the two types of heat sources also show differences in pig performance parameters including weight gain and mortality.

In conclusion, when comparing the incandescent light bulb with a radiant heat source, it was found that radiant heat gave an earlier and higher use of the creep area on the critical days after birth.

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Figure 1 Presentation of the experimental setup and housing. The experiment was conducted in two batches (winter and summer) in the same farrowing room with 10 identical farrowing crates. Pens had one of two heat sources: (1) a radiant heat source (RADIANT) or (2) an incandescent light bulb (STANDARD), with five of each heat source in each batch. The placement of the heat source was switched between the two batches.

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219 **Figure 2** Percentage of piglets in the creep area on day 1 to 7, 14 and 21 *post partum* for two
 220 types of heat sources (RADIANT: radiant heat source, n=10; STANDARD: incandescent light
 221 bulb, n=10). * $P<0.01$.

222
 223 **Figure 3** Percentage of piglets at the sow's udder on day 1 to 7, 14 and 21 *post partum* for two
 224 types of heat sources (RADIANT: radiant heat source, n=10; STANDARD: incandescent light
 225 bulb, n=10). * $P<0.01$.

227 **Table 1** *Definitions for piglet position in the farrowing pen.*

Position	Definition
Creep area ¹	The piglet is in the creep area.
Sows udder	The piglet is in physical contact with the sow's udder, or the piglet has physical contact with other piglets where at least one of those piglets is in physical contact with the sow's udder.
Other positions ¹	The piglet is not in the creep area or at the sow's udder.

228 ¹For piglets lying on the border between two positions, the position with more than 50% of the piglet's body

229 was recorded for that particular scanning.