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Piglet preference for infrared temperature and flooring

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Abstract

The aim of these experiments was to examine piglet preferences for different types of infrared temperatures and flooring at 24 hours of age. In Experiment 1, 10 piglets from each of 18 litters were distributed between three pairwise infrared temperature treatments (6 litters in each pairwise test): 26°C vs. 34°C, 26°C vs. 42°C or 34°C vs. 42°C. In Experiment 2, another 18 litters were tested in an identical setup with infrared temperatures of 30°C vs. 34°C, 30°C vs. 38°C and 34°C vs. 38°C. In Experiment 3, another 18 new litters were used to test the choice between foam mattress vs. sawdust, foam mattress vs. water mattress, and sawdust vs. water mattress. The preference test apparatus consisted of a box with three compartments: two test compartments and one neutral compartment in the middle. The piglets were released in the neutral compartment, and they were then allowed to explore all compartments and choose where to settle. Each litter was video recorded for one hour and the piglets' locations were scored every second minute. The results of Experiment 1 showed that the piglets had a significant preference for 42 °C compared to 34 °C ($t= -5.3$, $P<0.05$) and 26 °C ($t= -9.2$, $P< 0.01$). When subjected to smaller infrared temperature ranges in Experiment 2, the piglets showed no particular pattern in their choices. They significantly preferred to rest on a bed of sawdust compared to a foam mattress ($t= -2.9$, $P<0.05$) in Experiment 3. The piglets showed no other significant preferences between the floorings. The results indicate that piglets have a preference for high infrared temperatures and sawdust flooring, but it is unclear how precisely the piglets can distinguish between infrared temperatures when the differences are relatively small, especially at this young age.

Keywords: piglet, preference, infrared temperature, flooring, creep area.

1. Introduction

High piglet mortality is still a problem in the swine industry, and most of this mortality occurs within the first two days after farrowing (English and Morrison, 1984; Dyck and Swierstra, 1987; Andersen et al., 2005). Around 50-80 % of these early losses are normally attributed to starvation and crushing by the sow (e.g. Marchant et al., 2001), but hypothermia might often predispose piglets to starvation and crushing (e.g. le Dividich and Noblet, 1981; Edwards, 2002). Heat loss is especially critical for piglets directly after birth, as their thermoregulatory capacity is poorly developed compared to other newborn mammals which are born with fur and brown adipose tissue (e.g. Berthon et al., 1994). When the temperature drops below the piglets' thermoneutral zone (34-36 ºC), piglets try to increase their heat production by means of energetically demanding muscular shivering thermogenesis (Berthon et al., 1994), and they try to reduce their heat loss by social and individual thermoregulation (Mount, 1960; Vasdal et al., 2009).

Because room temperature in the farrowing unit is normally kept within the sows' thermal comfort zone, at around 20 °C (e.g. Svendsen and Svendsen, 1997), it is necessary to provide external heat sources and some sort of insulating flooring in the creep area to avoid hypothermic piglets. However, piglets prefer to lie close to the sow

during the first days after birth rather than in the heated creep area, despite unfavourable conditions in the sow area (Hrupka et al., 1998; Andersen et al., 2007; Moutsen et al., 2007), and will most commonly start to increase their use of the creep area from day 3 after birth (Hrupka et al., 1998; Berg et al., 2006). Newborn piglets are known to be attracted to thermal, olfactory, tactile and visual stimuli (e.g. Welch and Baxter, 1986; Parfet and Gonyou, 1991). By exploiting piglets' attraction to such stimuli, it is possible to increase the use of the creep area when the sow is present, either by reducing temperature in the sow area (Zhou and Xin 1999; Schormann and Hoy, 2006; Burri et al. 2009), by adding a warm water bed in the creep area (Ziron and Hoy, 2003) or by providing a simulated udder in the creep area (Lay et al., 1999; Toscano and Lay, 2005).

If the goal is to increase piglets' use of the creep area during the first critical days after farrowing, it seems important to increase the attractiveness of the creep area itself. Thus, we need to find out what temperatures and flooring the piglets prefer and are attracted to early after birth. In order to rank animals' preference for one resource over another, several methods have been applied in the literature. For instance, the importance of different resources can be assessed by demand functions based on operant techniques (e.g. Holm et al., 2007), where animals are asked to operate a manipulandum a certain number of times for access to a given resource. However, in order for this approach to work, the animals would need to be trained to operate the manipulandum, which would be difficult to manage for piglets at 24 hours of age, such as in this study. Alternatively,

animals' preferences can be examined using a choice test, where time spent with each resource serves as an indicator of the preference for that resource (e.g. Dawkins, 1977).

Piglets' preferences for heat and flooring have been studied in earlier reports, however these reports have tested either single piglets (Welch and Baxter, 1986; Parfet and Gonyou, 1990; Hrupka et al., 2000a; Hrupka et al., 2000b) or older piglets (Fraser 1985; Beattie et al. 1998). As the preference of an animal may be affected by social environment (e.g. Pedersen et al., 2002; Sherwin, 2003), it appears more relevant to test the litter together when aiming at increasing the attractiveness of a creep area. Individually tested piglets may have very different responses and preferences compared to when they are together with their littermates, and their preferences may be obscured by the effects of separation stress (e.g. Weary et al., 1999). Because preference may also be affected by age and experience (e.g. Dawkins, 1977), it is also important to test piglets soon after birth, in order to ascertain if they are able to make an active choice based on their preferences at this critical age.

The aim of these experiments was to examine the preferences for different types of infrared temperatures and surfaces in litters of 24 hour old piglets.

2. Material and methods

2.1. Experimental design

From each of 54 litters, 10 healthy piglets (Duroc boars mated with Landrace x Yorkshire sows) were randomly allotted to one of three experiments, with 18 litters at 24 hours of age in each experiment. Experiment 1 tested the preference between the following three temperatures: 26 °C, 34 °C and 42 °C (8-16 °C temperature difference). Experiment 2 tested the preference between another three temperatures: 30 °C, 34 °C and 38 °C (4-8 °C temperature difference). Experiment 3 tested the preference between three types of flooring consisting of a layer of sawdust over concrete, a foam mattress and a water mattress. In each experiment, the three possible combinations were tested pairwise with 6 litters in each combination. Each litter was tested only once.

2.2 Animals and housing

The sows were kept loose in individual pens, measuring 8.9 m² in total with 4.3 m² solid floor. The total sow area was 6.8 m² and the heated creep area measured 2.1 m² in total. The floor in the creep area was covered with a 4 cm layer of sawdust, while the solid floor in the sow area was covered in a 2 cm layer of sawdust. The air temperature in the farrowing unit was kept at 20 ºC until farrowing, and then reduced to 16 ºC. The creep areas were heated by a 250W heat lamp, providing an average infrared temperature of 26-28 ºC.

2.3. The test box

Three identical boxes (2.4 m x 0.8 m x 0.8 m) were made with solid walls, and each box was separated into three chambers, measuring 0.6 m² (Figure 1). The neutral compartment in the middle had a concrete floor and no roof, and the temperature was similar to the room temperature, around 18 ºC. The two test compartments had a 5 mm thick transparent acrylic ceiling, both to reduce convective heat loss and to facilitate video recording of the piglets' location. Plastic curtains covered the entrances of the two test compartments in order to create the correct thermal environments within and to avoid heating of the neutral area, while also making the compartments 100% visible for the piglets. During Experiments 1 and 2, both test compartments had a 5 mm rubber mat (de Laval®, www.delaval.com) on the floor.

Figure 1 here

The test compartments were heated by 250W infrared heat lamps in the ceiling, and 500W infrared heaters (Wimpel Golden Fie, www.wimpel.no) on one of the side walls were used to reach the higher temperatures. The temperatures were controlled by infrared temperature controllers (model VE122S IR controller, Veng Systems®, www.vengsystemer.dk) using an infrared temperature sensor (model VE181-50 speed/light sensor, Veng Systems®) mounted in the ceiling. The light intensity in the different temperatures was measured by a digital lux meter (TES® 1330 Digital Lux Meter). The illuminance ranged from 870 lux in the 26 ºC compartment to 1170 lux in the 42 ºC compartment, while the middle, neutral compartment was 280 lux.

In Experiment 3, the temperatures were kept constant at 34 ºC. The three different floorings consisted of either a 5 cm layer of sawdust on the concrete floor (SAW), a 2 cm thick foam mattress with plastic coating (Helly Hansen®) (FOAM) or a water mattress filled with 8 litres of warm water (MIK, www.mik-online.de) (WATER). In order to ensure that the piglets would not choose solely based on the familiarity of sawdust from their home pen, a small amount of sawdust (100 g) was sprinkled on both the foam mattress and the water mattress.

2.4. Experimental procedure

The piglets were tested as close to 24 hours of age as possible; however, litters were on average between 20 and 30 hours of age, due to some piglets being born during the night, while the testing commenced during the daytime. They were transported together from their home pen to the test box in an adjacent room. In order to provide the piglets with some experience with each temperature and flooring prior to the preference test, they were confined for 30 minutes in each of the two treatment compartments. The order in which the litters were placed in the treatment compartments was randomized between litters. After the 60 minutes had passed, the piglets were marked on their backs and returned to their home pen to suckle. When the sow had finished nursing, the marked piglets were again taken to the test area and placed in the neutral compartment between the two test compartments. The walls separating the two test compartments from the neutral area were then removed simultaneously, and the preference test began, lasting a

total of 60 minutes. No people were in the visual range of the piglets during the test, and the test was monitored by video. Immediately after the test finished, the piglets were returned to their home pen.

2.5. Behavioural observations

The piglets were continuously video recorded in the test box for 60 minutes. A digital video camera was suspended over each test box and connected directly to a computer with the MSH Video software (www.guard.lv). The numbers of piglets located in each of the two test compartments and in the neutral area were scored using instantaneous sampling every second minute for a total of 30 observations per litter. Fifty percent or more of the body inside the compartment was the criterion for scoring location in either of the two compartments. In Experiment 1, one litter had to be excluded due to technical problems with the test box.

2.6. Statistical methods

The mean proportion of piglets per litter that was located in each of the compartments and the neutral area during the observation period was used as the statistical unit. Matched pair Wilcoxon signed rank tests were used to determine any significant preferences between the two compartments in each test. We also carried out a descriptive analysis of the preferences of individual litters, to investigate how consistent these preferences were. For a given litter, the scores of number of piglets in each location were

summed across all observations and a compartment was said to be preferred if the total occupancy score for that compartment exceeded 60 % of the total score for all compartments.

3. Results

3.1. Experiment 1: 26, 34 and 42 ºC

The piglets showed a significant preference for 42 ºC over both 26 ºC ($t= -9.2$, $P<0.01$) and 34 ºC ($t= -5.3$, $P<0.05$, Figure 2), but the piglets showed no significant preference between 26 ºC and 34 ºC (Figure 2). On average, less than 10 % ± 1.4 of the piglets were lying in the neutral area during the tests. When 42 ºC was one of the options, 19 % ±1.7 of the piglets were lying in the neutral area, due to some piglets lying partly outside the 42 ºC area. More than 80 % of the piglets had settled in one of the compartments within the first 10 minutes of the test in 14 of the 17 litters, where they remained throughout the test period.

Figure 2 here.

When using the 60 % criterion for preference it was clear that although there were no overall significant preferences in the 26 ºC vs. 34 ºC test, the occupancy scores indicated that four of the six litters preferred 34 ºC to 26 ºC, while two of the litters preferred 26 ºC

(Table 1). In the 26 ºC vs. 42 ºC test, four of the five litters preferred 42 ºC, and one litter showed no clear preference. In the 34 ºC vs. 42 ºC test, four of the six litters preferred 42 ºC, while two litters showed no clear preference.

Table 1 here

3.2. Experiment 2; 30, 34 and 38 ºC

The piglets showed no significant preference when offered the choice between 30 ºC vs. 34 ºC, 30 ºC vs. 38 ºC or 34 ºC vs. 38 ºC (Figure 3). On average, less than 5 % ± 0.8 of the piglets were lying in the neutral area during these tests, while 18 % ± 3.8 of the piglets were lying in the neutral area in the 34 ºC vs. 38 ºC test. More than 80 % of the piglets had settled in one of the compartments within the first 10 minutes of the test in 14 of the 18 litters, where they remained throughout the test period.

Figure 3 here

When using the 60 % criterion as mentioned above, there did not appear to be a pattern in the preference of the litters. Three of the six litters preferred 30 °C over 34 °C, while two litters preferred 34 °C and one litter did not show any clear preference (Table 2). In the test 30 °C vs. 38 °C, three litters preferred 30 °C while three litters preferred 38 °C (Table

2). When testing 34 °C against 38 °C, two litters preferred 34 °C; three litters preferred 38 °C and one litter did not show any clear preference.

Table 2 here.

3.3. Experiment 3: Flooring

The piglets significantly preferred SAW to FOAM ($t=-2.9$, $P<0.05$) (Figure 4). However, there were no significant preferences between SAW and WATER, or between WATER and FOAM (Figure 4). The piglets clearly avoided the neutral concrete area; less than 4 % ±1.1 of the piglets were lying in the neutral area during the three different tests. More than 80 % of the piglets had settled in one of the compartments within the first 10 minutes of the test in 13 of the 18 litters, where they remained throughout the test period.

Figure 4 here

When using the 60 % criterion for flooring preference, five of the six litters prefered SAW over FOAM, while only one litter preferred FOAM (Table 3). Four of the six litters preferred SAW over WATER, while two litters preferred WATER (Table 3). When testing FOAM against WATER, three of six litters preferred WATER and one litter preferred FOAM, while two litters showed no clear preference between the two.

Table 3 here.

4. Discussion

The piglets preferred the warmer temperature in Experiment 1 when the temperature differences were large (8-16 ºC). This confirms earlier findings that piglets are able to choose their location based on the thermal environment (e.g. Titterington and Fraser, 1975; Farmer and Christison, 1982; Welch and Baxter, 1986), and that they seem to prefer temperatures above their thermoneutral zone (Hrupka et al., 2000b). Although the light intensity increased with increasing infrared temperatures, earlier studies have found that newborn piglets clearly prefer dark areas over bright light (e.g. Parfet and Gonyou, 1991), which is as an adaptive behaviour as it will encourage the piglets to remain in the dark nest. The fact that the piglets preferred the higher infrared temperatures despite the higher illumination levels suggests that the preference for temperature exceeds their preference for darkness.

There was no clear temperature preference in Experiment 2, when the temperature differences were smaller. This suggests that they were either unable to differentiate between these temperatures or had no preference for temperatures in the range tested. Under natural circumstances, piglets do not need to be fine tuned to specific temperatures; instead they would be attracted to the warmest surface in their

surroundings, i.e. the sow's udder (e.g. Fiala and Hurnik, 1983). The presence of a cooler, neutral area between the two test compartments may have made the discrimination more difficult. However, the fact that the piglets clearly avoided the neutral area, which was 12-20 ºC cooler than either of the test compartments, indicates that they had the ability to discriminate when the temperature difference was sufficiently great.

The piglets rarely changed their location once they had settled in one of the test compartments. A possible explanation for this might be that all the temperatures in the test compartments were higher than the room temperature, and will thus have been perceived as rewarding compared to the neutral area. The piglets also had to cross the colder neutral area to get to another compartment, which may have reduced the probability of further movement once they had entered a compartment. The fact that piglets preferred to stay together with their littermates fits well with an earlier finding; piglets prefer to lie close together despite having enough room to spread out even at temperatures over 40 ºC (Vasdal et al., 2009). A relatively strong motivation to lie together is adaptive for the piglets due to the positive effects of social thermoregulation, the reduced chance of being detected by predators and the reduced risk of being trampled on or crushed by the sow. Consistent with this motivation for social contact, we observed that when the first piglets settled in one of the compartments, the other piglets soon followed, settled next to them, and remained there throughout the test period. Some of the piglets that chose the 42 ºC compartment were observed to lie with part of their bodies outside the heated area, possibly indicating that the temperature was too high for their comfort. The motivation to

lie together with other piglets thus may be stronger than the motivation to seek out a more optimal thermal environment.

When given the choice between different floorings, the piglets preferred sawdust to the foam mattress, but they showed no preference between sawdust and the water mattress. Sawdust is attractive due to its thermal qualities and the fact that it is soft and easy to manipulate. The preference for sawdust might also have been due to the familiarity of this substrate from their home pens, with its positive associations to maternal smells (e.g. Morrow-Tesch and McGlone, 1990). When tested with crated sows, a water mattress was preferred over foam mats, heated plates and straw in three-day old piglets (Ziron and Hoy, 2003). However, as the water mattress in our study was heated by a heat lamp and not floor heating, the surface temperature might have been too high. Another potential problem with both the water and the foam mattresses could be the smell of plastic. Both types of mattresses were new, and as piglets have a well developed sense of smell (e.g. Parfet and Gonyou 1991), the unfamiliar smell of plastic might have been aversive. Another possible explanation for the flooring preferences displayed by the piglets might be that the 30 minutes of experience before the test started was too little to induce any positive associations with the mattresses, compared to the 24 hour experience they had had with the sawdust in their home pens. In the future, it would be interesting to consider whether experience with the two types of mattress in the home pen prior to the tests would have an effect on the preferences displayed.

In conclusion, these experiments show that piglets have the ability to assess their environment, and that they have clear preferences for specific infrared temperatures and floorings at 24 hours of age. While there was no preference between 26 ºC and 34 ºC, the piglets clearly preferred 42 °C over both 34 °C and 26 ºC, which suggests that their thermal preference is higher than their thermoneutral zone. Sawdust was also preferred to a foam mattress, although this may have been because they had already formed a positive association between sawdust and their home pen.

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Tables

Table 1. Descriptive analysis of preference for different infrared temperatures in Experiment 1.

Experiment	Preference	Number of litters
26 °C vs. 34 °C	26 °C	2/6
	34 °C	4/6
	Neutral area	0/6
	No clear preference	0/6
26 °C vs. 42 °C	26 °C	0/5
	42 °C	4/5
	Neutral area	0/5
	No clear preference	1/5
34 °C vs. 42 °C	34 °C	0/6
	42 °C	4/6
	Neutral area	0/6
	No clear preference	2/6

The criterion for temperature preference was that when scores of the number of piglets in each location were summed across all observations, the compartment at that temperature should score more than 60% of the total.

Table 2. Descriptive analysis of preference for different infrared temperatures in Experiment 2.

Experiment	Preference	Number of litters
30 °C vs. 34 °C	30 °C	3/6
	34 °C	2/6
	Neutral area	0/6
	No clear preference	1/6
30 °C vs. 38 °C	30 °C	3/6
	38 °C	3/6
	Neutral area	0/6
	No clear preference	0/6
34 °C vs. 38°C	34 °C	2/6
	38 °C	3/6
	Neutral area	1/6
	No clear preference	0/6

The criterion for temperature preference was that when scores of the number of piglets in each location were summed across all observations, the compartment at that temperature should score more than 60% of the total.

Table 3. Descriptive analysis of preference for different floorings in Experiment 3.

Experiment	Preference	Number of litters
SAW vs FOAM	Sawdust	5/6
	Foam mattress	1/6
	Neutral area	0/6
	No clear preference	0/6
SAW vs WATER	Sawdust	4/6
	Water mattress	2/6
	Neutral area	0/6
	No clear preference	0/6
FOAM vs WATER	Foam mattress	1/6
	Water mattress	3/6
	Neutral area	0/6
	No clear preference	2/6

The criterion for flooring preference was that when scores of the number of piglets in each location were summed across all observations, the compartment with that flooring should score more than 60% of the total *(SAW = sawdust; FOAM = foam mattress; WATER = water mattress)***.**

Legends to figures

Figure 1. One of the three identical test boxes with heat lamps in the ceiling and plastic curtains in the entrance of the test compartments.

Figure 2. The percentage of piglets per litter choosing test compartments at different temperatures (n=6 litters). (Differences between temperatures are indicated by letters: a,b: P<0.05, c,d: P<0.01)

Figure 3. The percentage of piglets per litter choosing test compartments at different temperatures (n=6 litters).

Figure 4. The percentage of piglets per litter choosing test compartments with different floorings (n=6 litters; Saw = sawdust; Foam = foam mattress; Water = water mattress). (Differences between floorings are indicated by letters: a,b: P<0.05.)

Figures

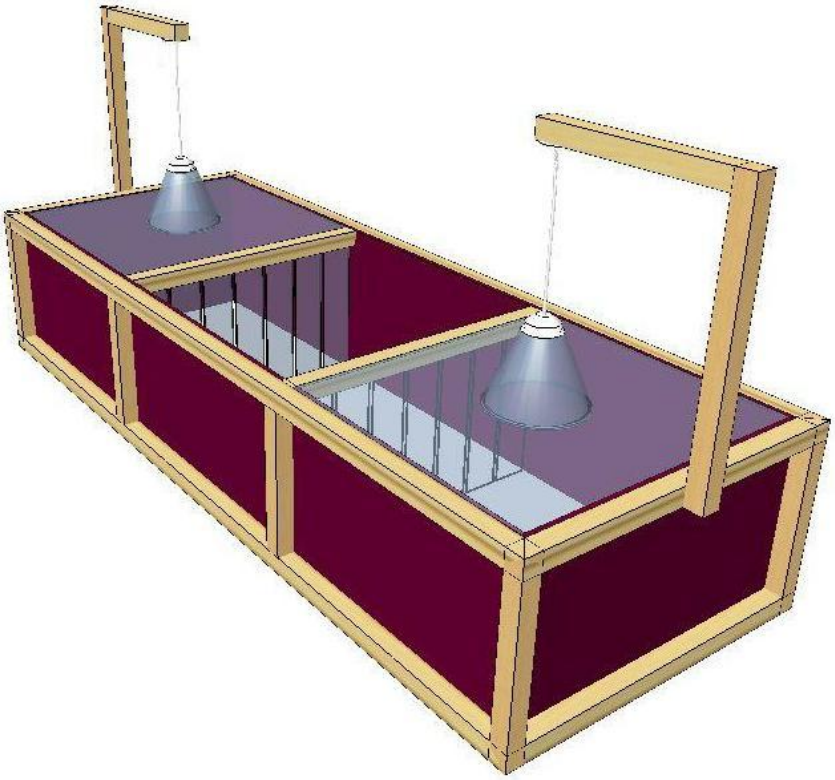

Figure 1.

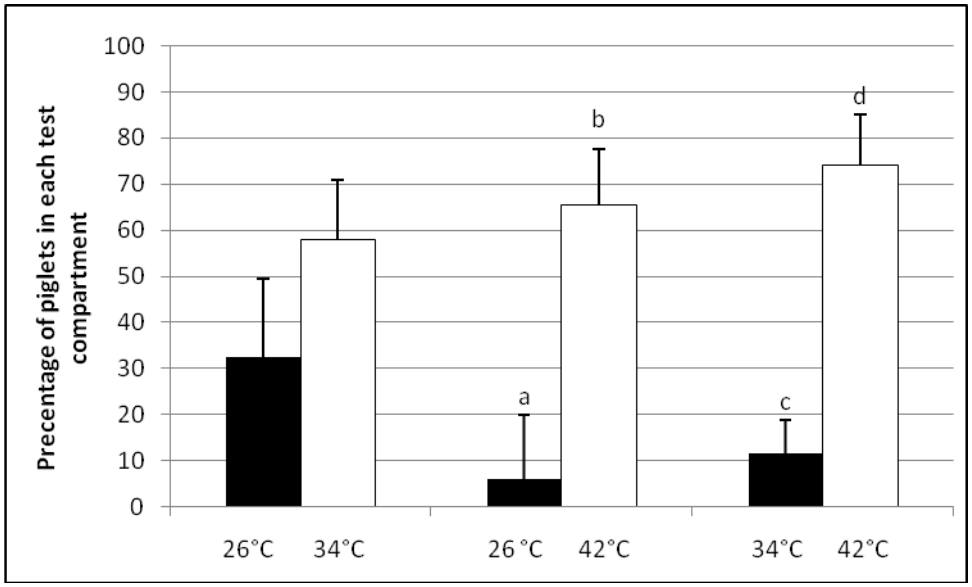
Precentage of piglets in each test compartment
100
90
80
70
60
50
40
30
20
10
0
a
b
c
d
26°C
34°C
26 °C
42°C
34°C
42°C

Figure 2.

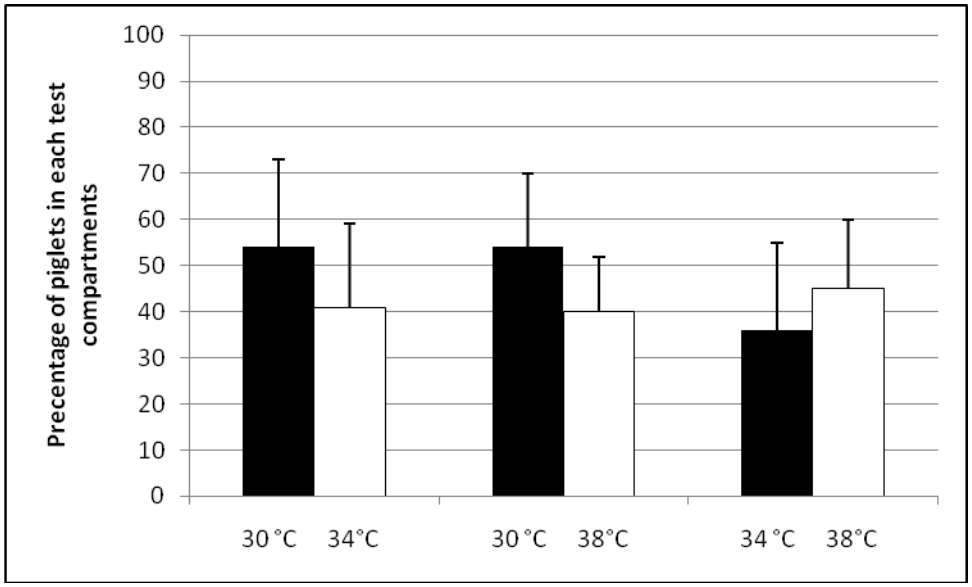
Precentage of piglets in each test compartments
100
90
80
70
60
50
40
30
20
10
0
30 °C
34°C
30 °C
38°C
34 °C
38°C

Figure 3.

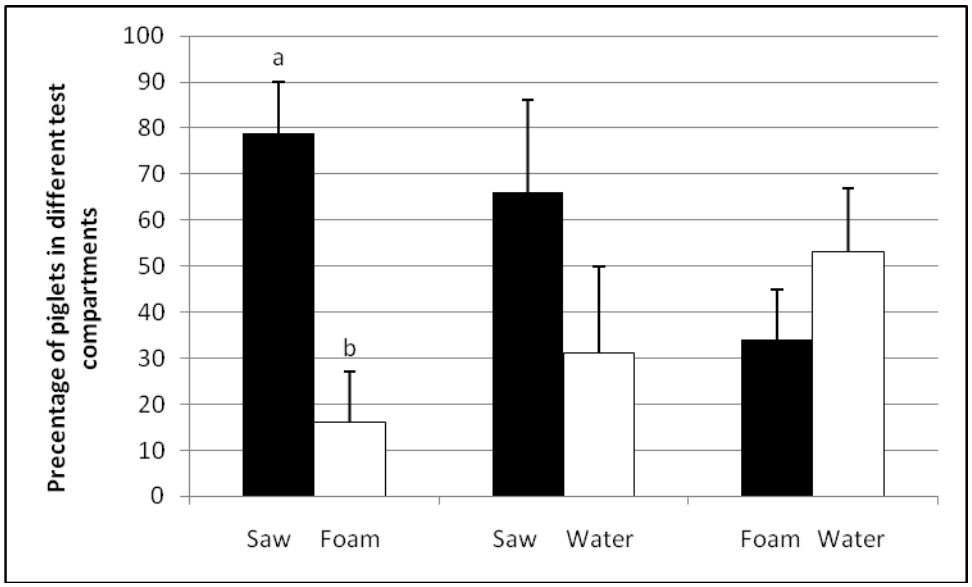
Precentage of piglets in different test compartments
100
90
80
70
60
50
40
30
20
10
0
a
b
Saw
Foam
Saw
Water
Foam
Water

Figure 4.