Newly weaned piglets show a strong preference towards centrally positioned circular feeder

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ABSTRACT
At weaning, piglets undergo an immediate transition from mother’s milk to the feed mixture. Feed refusal and growth lag is, therefore, a frequent feeding disorder in newly weaned piglets. The present study aimed to determine whether newly weaned piglets adapt their feeding preferences towards feeders of different types/shapes and positions. A total of 120 piglets were included in the study. The analysis was carried out in low- and high-density groups, with 10 or 20 individuals per pen, respectively. Two different feeders were present in the weaning pen: a hopper (circular/central) and a trough (rectangular/sidewall). Piglet activity was video-recorded, and the number of piglets in each feeder was counted. The results showed nearly five times higher competition at the feeder in the high-density groups \( (p < .0001) \). In both high- and low-density groups, piglets showed a significant preference towards the hopper \( (4 \text{ and } 24 \times \text{ higher number of piglets at the hopper compared to the trough, respectively; } p < .0001) \). The trough feeder was mainly chosen when the (preferred) hopper feeder was occupied by a higher number of piglets \( (p < .0001) \). There are several co-founding factors that explain the observed phenomenon: the distance from the resting area, the perception of the circular feeder as less competitive, and contra-freeloading. However, the results showed that the feeder type/position should be considered when planning the layout of a weaning pen.

HIGHLIGHTS
- Weaners showed markedly higher competition at the feeder at high stocking density.
- Weaners preferred circular feeder (hopper) placed in the middle of a pen.
- Unlimited circular space, position (proximity to lying area), and contra-freeloading may explain hopper preference.

Introduction
Weaning is accompanied by a considerable change in the living environment for piglets, including space and feed. At weaning, piglets are transferred to a new pen, suddenly deprived of milk, and offered a feed mixture instead. Such sudden changes are usually accompanied by a low feed-intake with episodes of diarrhoea that lead to a negative daily gain in the piglets (Pluske et al. 1997). A variety of measures can prevent such negative consequences, such as weaning at an older age (Wellock et al. 2007; Leliveld et al. 2013), adapting the composition of the feed mixture (Collins et al. 2017), or adding supplements to the feed (Biagi et al. 2006; Brus et al. 2013). However, the feeding behaviour of piglets can also be influenced by the characteristics of the living space (Andersen et al. 2004), such as the shape and size of the pen (space allowance per pig), floor type, temperature, air velocity, and, ultimately, positioning of the pen equipment/elements (Close et al. 1981; Jørgensen 2003; Magowan et al. 2008; Jensen et al. 2012; Ocepek et al. 2018). As for the latter, a few studies on the effect of feeder design on the performance and feeding behaviour of pigs have already been conducted. For example, O’Connell et al. (2002) compared post-weaning food competition at different types of feeders and found that the level of food competition changes with feeder type as well as affecting the competitive behaviour between weaned pigs in general; however, it does not necessarily impact pig performance (Walker 1990). Nevertheless, not only the number of feeding sites and feeder size but also their positioning...
could impact feeding behaviour, which has not yet been extensively studied.

The aim of the present research was, therefore, to investigate the effect of the shape/type of the feeder (hopper vs trough) on the feeding behaviour of pigs, that is, their preferences towards a certain type of feeder. In the present study of feeding preferences, two different types of feeders were installed in the weaning pen – the standard feeder (trough) along the sidewall and the circular hopper feeder in the middle of the pen. In addition, we also tested the preferences of the piglets in high and low stocking density groups. Following our observations, we assumed that piglets’ feeding preferences depend on the position and shape of the feeder. According to our previous but occasional observations, we hypothesised that piglets prefer to eat from centrally positioned circular feeders.

Materials and methods

Animals and housing

This study was carried out according to the Directive 2010/63/EU (The European Parliament and the Council of the European Union 2010). The research was conducted under farm conditions in accordance with Council Directive 2008/120/EC (The Council of the European Union 2009). Thus, no experimental animals were included and, therefore, approval from an ethical committee was not required. The experiment involved 120 cross-breed (Swedish Landrace × Large White) piglets from 13 consecutive litters with an average size of 10 (±0.9) piglets. In order to form experimental groups of equal size (20 or 10 piglets), piglets with the lowest body weight were excluded from the original litter. Surgical castration of the male piglets was performed 3 or 4 days postpartum. Cross-fostering was not performed in any of the litters. Before the expected date of parturition, the sows were transferred to individual farrowing pens. Each farrowing pen had a covered area for piglets that was heated to 30°C using a 150 W infra-red heating lamp and a heating plate. The temperature in the uncovered position of the pen was 18–22°C and controlled by a ventilation system. The pens had solid plastic sidewalls and concrete flooring, which was partially slatted (≈1/3) and wrapped with perforated plastic material. Within the second week of the lactation period, piglets were offered a pre-starter feed mixture in the small trough (W × L × D, 10 × 30 × 5 cm) installed on the sidewalk beside the drinker.

Weaning and formation of groups

The piglets were weaned 33 days postpartum. One week before weaning, they were marked with plastic ear-tags (numbers) to differentiate the individuals. After weaning, the piglets were placed in weaning pens (2.0 m × 2.0 m, no access to an outdoor area). The pens were separated by 100-cm high metal-lattice barriers. Approximately 2/3 of each pen had a metal slatted floor wrapped with perforated plastic material. The remaining 1/3 was covered with solid rubber to ensure that this area had a higher temperature. The average room temperature was maintained at 26°C. A combination of daylight entering through the windows and artificial lighting was used to guarantee 14 h of light (of at least 40 lx) and 10 h of darkness per day. The distribution of piglets in the weaning groups was balanced according to body weight and sex. The experiment was carried out in four repetitions, with the group size (i.e. density of pigs per unit) being a varying factor. In the first part of the experiment, two repetitions were formed with large weaning groups of 20 piglets with 0.2 m² of surface per piglet (a total of 80 piglets were involved). In the second part of the experiment, two repetitions were performed with small weaning groups of 10 piglets with 0.4 m² of surface per piglet (a total of 40 piglets were involved). Piglets were weighed at weaning and seven days after weaning.

Feeding and feeding behaviour

There were two types of feeders in the weaning pens: hopper (plastic feeder of circular shape with a red feeding bowl and an opaque, transparent feed container) and trough (rectangular grey sheet-metal feeder). As shown in Figure 1, the hopper was located in the middle of the pen and had 10 feeding places with a width of 11.2 cm for one feeding place. The trough was located alongside the pen and had eight feeding places with a width of 13.2 cm for one feeding place. Other dimensions of the feeders are specified in Figure 1. The piglets were fed ad libitum with a commercial balanced dry feed mixture for weaned piglets and had free access to water.

The feeding behaviour was monitored with an IP camera fixed to the ceiling of each weaning pen. Snapshots of the video recordings were taken on the day of weaning (day 0) and 1, 2, 3, and 7 days after weaning. For each day, 20 snapshots were taken at three-minute intervals in the morning (8:00 – 9:00), immediately after the addition of fresh feed, when the piglets were most active. Each snapshot was then
analysed, and the number of piglets fed at the hopper or trough was counted manually, that is only piglets that showed clear feeding activity (feed manipulation) were counted. It is important to note that we were not able to distinguish between individuals, so only the number of piglets present/fed at a particular feeder at a particular time was recorded, which provided information on general group feeder/feeding place preferences (and feeding competition indirectly).

**Data analysis**

Basic statistics of feeding visits for both feeders (hopper and through) were calculated (sum of all snapshots per pen during the observation period, median, and quartiles). The obtained data (total number of visits) were statistically analysed with and without consideration of the group size. Deviations of the actual number of visits from the expected were evaluated using the Chi-square ($\chi^2$) test. The number of visits at different feeders was further analysed by experimental days (0, 1, 2, 3, and 7). The relationship between visiting hoppers and trough feeders was also evaluated. For this reason, the distribution of visits was presented using box and whisker plots and tested using the Mann–Whitney U test. All statistical analyses were performed using IBM SPSS Statistics 25.

**Results and discussion**

The piglets involved in the present study were weaned with a bodyweight of 9.7 kg and a daily gain of 330 g per day, respecting a period of two weeks after weaning (data not shown). It is important to note that the present study was not specifically designed as a preferential test but was an attempt to try to explain an interesting phenomenon that had coincidentally been observed in another study (Mesarec et al. 2017). Therefore, the design of this study had some limitations, especially the number of repetitions, which consequently did not enable testing of all possible factors important for piglet choice and preference for different feeders.

The results for the number of visits at different feeders over the entire observation period (5 days, 20 snapshots within one hour) showed fivefold more piglet visits to the hopper (1220) compared to the trough feeder (244, $p < .0001$; Table 1), independent of group size/density. Concerning the time component, it was observed that this pattern occurred throughout the entire observation period (Table 1). However, the interest in the hopper was even more pronounced immediately after weaning, whereby hopper was visited 8 or 12 times more frequently on day 0 or 1, then by the trough feeder (on the following days, the ratio was about 4:1).

Regarding the group size/density (Table 1), the number of feeder visits throughout the study period was generally 4.9-times higher in large (1215 visits) than in small groups (249 visits), although the density in large groups was only twice as high as in small ones (20 vs 10 pigs per pen). Despite ad libitum feeding, this result implies significantly higher competition at the feeding place in larger groups.
Regarding the type of feeder, similar relationships between visiting hoppers and troughs were observed in both group sizes (Table 1). In small and large groups, piglets unambiguously preferred visiting hopper feeders (Table 1). In large groups, the number of visits to the hopper was 4.2-times higher compared to the trough (981 vs 234, respectively). In small groups, this number was 23.9-times higher (239 vs 10, respectively). Moreover, since at low density, there were enough feeding places for all piglets in the hopper, the trough was, consequently, hardly used.

The relationship between the visits to both feeders in general showed (Figure 2) that the trough feeder was unoccupied when the hopper was occupied by a small number of piglets (0 or 1 in half of the cases, on average 1.8 piglets). On the other hand, when at least one piglet ate at the trough, a significantly higher number of piglets were also observed at the hopper (1–5 in half of the cases, on average 3.0 piglets).

The results of the present study, therefore, showed the importance of the position and shape of the feeder for the feeding behaviour/preferences of weaned piglets. Weaned piglets showed clear preferences for a feeder with a circular shape placed in the middle of a weaning pen (also closer to the resting area), while rectangular feeders placed alongside the pen were significantly less frequently visited during feeding (Table 1). Therefore, these results provide useful information for overcoming the considerable stress of the weaning transition, including refusal of food. Indeed, food refusal is one of the most common feeding disorders occurring at weaning, when piglets are exposed to a sudden transition from maternal milk to creep feed. As a result, piglets are at least partially deprived of feed at weaning, resulting in negative daily gains and increased incidence of diarrhoea (Pluske et al. 1997).

Due to the pen space optimisation and provision of sufficient space for moving and resting, the feeders are usually placed on a sidewall or in the corner of the pen (Wiegand et al. 1994). However, according to our results, a sidewall position seemed to be far less attractive for piglets that visited it rather occasionally, whereas centrally positioned circular feeders, by contrast, were visited significantly more often, almost exclusively (Table 1).

One important aspect to consider is the animal’s perception of the space at the feeding place, including its boundaries. We can assume that piglets perceive a circular hopper feeder as virtually unlimited space, that is, as a less competitive and preferable environment. The trough, on the other hand, is a geometrically constrained, limited space that the animals can perceive as a potentially more competitive feeding environment. Nevertheless, we recorded feeding at the sidewall feeder; however, given the relationship between the occupancy of both feeder types, we suggest that an unfavourable sidewall feeder is more likely to serve as an alternative feeding option if the preferred source (i.e. circular feeder) is overcrowded.

The avoidance of fierce competition is usually observed in social animals, where individuals normally forage in close proximity and therefore tend to reduce local competition and conflicts within the group by resource partitioning through subgrouping (Sheppard et al. 2018). However, in terms of spatial perception, Nielsen et al. (1996) came to slightly different conclusions. Their study did not find significantly different feeding patterns in terms of feeder visits when the feed was available in the single-space feeder (computer-controlled feeding system where only one pig

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**Table 1. Number of piglets eating at different feeders.**

|                | Hopper | Trough | p Value |
|----------------|--------|--------|---------|
| **Overall**    |        |        |         |
| Sum            | 1220   | 244    | <.0001  |
| Median [Q1–Q3]| 2 [0–3]| 0 [0–1]|         |
| **Experimental day** |        |        |         |
| 0 Sum          | 111    | 14     | <.0001  |
| Median [Q1–Q3]| 1 [0–1]| 0 [0–0]|         |
| 1 Sum          | 264    | 22     | <.0001  |
| Median [Q1–Q3]| 2 [1–4]| 0 [0–0]|         |
| 2 Sum          | 336    | 85     | <.0001  |
| Median [Q1–Q3]| 3 [1–4]| 0 [0–1]|         |
| 3 Sum          | 255    | 66     | <.0001  |
| Median [Q1–Q3]| 2 [0–3]| 0 [0–1]|         |
| 7 Sum          | 254    | 57     | <.0001  |
| Median [Q1–Q3]| 1 [0–3]| 0 [0–1]|         |
| **Group size** |        |        |         |
| small Sum      | 239    | 10     | <.0001  |
| Median [Q1–Q3]| 1 [0–2]| 0 [0–0]|         |
| large Sum      | 981    | 234    | <.0001  |
| Median [Q1–Q3]| 2 [0–4]| 0 [0–1]|         |

Q1: first quartile; Q3: third quartile.
could enter at a time) and the multi-space trough (usually used on farms and allowing several animals to feed simultaneously).

Furthermore, animals naturally make considerable efforts (time and energy) to obtain food. Accordingly, several researchers have demonstrated that captive animals prefer to work for food that is otherwise freely available, a behaviour known as contra-freeloading (reviewed by Price 1999). In our research, the feed in the trough was also freely available, while piglets had to push the hopper feeder in order for the feed to be poured out. Therefore, hopper feeders can also be considered more attractive because the piglets had to work to receive the feed.

Notably, the feeders were not of the same colour (the trough was of grey/metal colour, but the hopper was partly red); therefore, this could potentially be considered a factor in piglets’ choice and preference. However, a study by Klocek et al. (2016) showed significant avoidance behaviour only towards a yellow-coloured feeder, but not towards a red and a blue one, which were most and indiscriminately visited.

The present study follows on from many previous studies showing that planning the layout of equipment in the pen is important from various perspectives; thus, a careful design of the pen contributes considerably to animal welfare, development, and growth and plays an important role from an economic point of view (e.g. Andersen and Pedersen 2011).

Conclusions
Our results showed that the position and shape/type of feeders in the weaning pen requires special attention. Installing the hopper feeder in a central position seems desirable as it could encourage the piglets to a more rapid transition to the creep feed after weaning.

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