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Promoting sow-piglet information transfer and playful foraging by changes in pen design and feeding strategy to ease weaning: effects on pig performance and behaviour

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ABSTRACT

Strategies inspired by the natural behaviour of pigs, including learning from the sow and playful foraging, may alleviate behavioural problems in weanling piglets and enhance their performance. We investigated the effects of a 'family feeding system' (**Fs**) and a dietary treatment providing 'family feeds' (**Ff**) in a 2 × 2 design on performance and behaviour until day 35 postweaning. Sows (n = 104) and piglets were either kept in the Fs or in a conventional system (**Cs**), and fed either the Ff or not (**Cf**). Fs sows could obtain feed throughout the day provided on a plate accessible to the piglets. Piglets and sows could also jointly drink and explore enrichment materials. The piglet feeder was identical in both systems, but in the Fs, it contained enrichment materials to stimulate playful foraging. Piglets were weaned at 27 days of age. Ff piglet feed, offered from postnatal day 2 until day 9 postweaning, contained the artificial flavour and several ingredients of the Ff sow's diet, allowing for flavour transfer, and had varying pellet size and length to increase texture diversity. Fs piglets were, apart from piglet feed, provided with sow feed for the first 4.5 postweaning days. Sow and piglet performance and body damage, number of eaters and postweaning behaviour and diarrhoea were determined. Less Fs than Cs sows had shoulder lesions. In the Fs, the proportion of eaters, preweaning piglet growth and weaning weight were higher. Until day 9 postweaning, Fs piglets' feed intake was higher, but growth lower, possibly due to a higher incidence of diarrhoea in this period. BW at day 35 postweaning was unaffected by system. Ear and tail damage and body lesion scores were decreased in Fs compared to Cs piglets pre- and postweaning, along with ear and tail biting behaviour postweaning. The Ff did not affect preweaning performance, but increased postweaning diarrhoea until day 9, proportion of piglets with damaged ears on day 9 and tail biting frequency, with no effect on postweaning growth. The postweaning intake of sows' feed in Fs piglets and the use of ingredients from the sows' diet in the Ff piglet diet might partly explain the high incidence of diarrhoea in these piglets, and thereby the absence of positive effects of the Fs and Ff on postweaning gain. In conclusion, strategies based on the natural behaviour of pigs seem promising to enhance piglet welfare around weaning, but further adjustment to their postweaning nutritional needs is required.

Implications

Impact of a 'family feeding system', allowing piglets to eat with the sow in a playful manner, and 'family feed', allowing for flavour learning, on piglet performance was investigated. The family system increased the number of eaters and growth preweaning, and reduced tail and ear biting, body lesions and tail and ear wounds in the weeks after weaning. However, the family system and family feed increased postweaning diarrhoea and did not enhance postweaning growth. Strategies based on pigs' natural behaviour thus seem promising to enhance piglet welfare around weaning, but further adjustment to their postweaning nutritional requirements is needed.

Introduction

Weaning at a young age is a stressful event for piglets, exposing them to abrupt dietary and environmental changes (Weary et al.,

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2008). Weaning often results in poor growth (Heo et al., 2013), diarrhoea (Zheng et al., 2021) and the development of damaging behaviours, such as tail and ear biting (Colson et al., 2006; Oostindjer et al., 2011b). Part of these problems may be related to a poor postweaning feed intake, as many weanling piglets are reluctant to eat (see Wensley et al., 2021; Blavi et al., 2021 for review). This poor feed intake may be linked to limited experience in eating solid feed, as pre- and postweaning feed intake of piglets are positively correlated (e.g., Berkeveld et al., 2007). Suckling piglets identified as 'eaters', i.e. ingesting solid feed, not only eat more after weaning but also have a higher growth in the immediate postweaning period (e.g., Sulabo et al., 2010), and a more mature microbiota and digestive and immune system in the gut (Choudhury et al., 2021, 2023). Therefore, it seems important to accustom piglets to solid feed preweaning. However, suckling piglets vary largely in feed intake, and many do not ingest feed at all (e.g., Sulabo et al., 2010; van Nieuwamerongen et al., 2015). Some strategies to stimulate preweaning feed intake and postweaning performance have been put forward that are inspired by the natural behaviour of pigs (Blavi et al., 2021). For instance, stimulating playful feed exploration by providing suckling piglets with large pellets that can be moved around (Van den Brand et al., 2014), a diverse diet (Middelkoop et al., 2018, 2019a) or a 'play feeder' with manipulable materials (Kuller et al., 2010; Middelkoop et al., 2019b) has been shown to benefit feed intake (Kuller et al., 2010), number of good eaters preweaning (Middelkoop et al., 2019a) and/or postweaning performance (Van den Brand et al., 2014; Middelkoop et al., 2019b; Craig et al., 2021) and reduce damaging behaviour (Middelkoop et al., 2019b).

Additionally, facilitating information transfer between the sow and her piglets seems a promising strategy to ease the weaning transition. This mother-offspring information transfer already starts *in utero*, where foetuses are exposed to flavours from their mother's diet (Blavi et al., 2016). Re-exposure to these prenatally sensed flavours at weaning has been shown to benefit growth (Oostindjer et al., 2010; Blavi et al., 2016), feed intake, gut functioning and behaviour in the early postweaning period (Oostindjer et al., 2010), likely to a large extent via reducing weaning stress (Oostindjer et al., 2011b; Oddo et al., 2016). Transfer of flavours from the maternal diet also occurs via the sow's milk, albeit a lower transference via this pathway has been suggested (Blavi et al., 2016). Apart from this form of learning via perinatal flavour transfer, observation of the sow's feeding behaviour seems to stimulate piglet feed intake. Piglets were reported to eat more feed if they had previously observed their mother to ingest this feed, and they also paid attention to the location of their mother's feeder (Oostindjer et al., 2011a). Facilitating sow-piglet information transfer in different ways may thus positively affect piglet performance around weaning (Oostindjer et al., 2014; Wensley et al., 2021). Conventional farrowing systems, however, hardly allow for such information transfer to occur as piglets usually receive feed that is different from their mother's diet, and are not able to eat from the same feeder or even properly observe the sow while she is eating.

To our knowledge, the above-mentioned strategies – based on the natural behaviour of pigs – that may benefit piglet performance have not been tested collectively in a commercial setting. Therefore, in the current study, the impact of a 'family feeding system', stimulating eating with the sow and playful foraging, and a dietary treatment based on 'family feed', allowing for sow-piglet flavour transfer and with varying pellet size and length, on piglet performance up to 9 weeks of age was tested. We hypothesised that both the family feeding system and the family feed dietary treatment would lead to a higher preweaning feed intake and growth, and a larger number of eaters, which would in turn benefit postweaning performance, gastrointestinal health, as reflected in lower diarrhoea prevalence, and behaviour.

Material and methods

The study was set up as a 2 × 2 factorial design with feeding system and dietary treatment as factors. The feeding system treatment was either a control, conventional system (**Cs**) or a family feeding system (**Fs**). The dietary treatment consisted of either control, conventional feeds (**Cf**) or family feeds (**Ff**). Thus, the combination of feeding system and dietary treatment led to four different treatment groups: Cs-Cf, i.e. a conventional, control system with conventional feeds provided; Cs-Ff, i.e. a conventional system with family feeds provided; Fs-Cf, i.e. a family system with conventional feeds provided; Fs-Ff, i.e. a family system with family feeds provided. Below, more details on the treatments are given. Feeds were provided by Trouw Nutrition, Boxmeer, the Netherlands.

Animals and housing

The experiment included 104 sows, parity 1–7 (mean ± SEM = 3.4 ± 0.2) and their litters (Tempo boar × TN70 sow), n = 26 per treatment, and was conducted at the Swine Innovation Centre, Sterksel, the Netherlands. Animals were distributed over eight batches; five batches with 16 and three with eight sows. Assignment of sows to treatments was balanced for parity and expected farrowing date, with similar sow BW (280.6 ± 2.7 kg) and backfat depth (16.2 ± 0.3 mm). Per batch, two farrowing and two nursery rooms were available. Pens in the two farrowing rooms slightly differed in size and in heating method of the piglet nest (see below). The two nursery rooms used were identical. Distribution of sows and piglets between rooms was balanced for treatment.

Preweaning

From 1 week before expected farrowing, sows were housed in crates in farrowing pens (1.75 × 2.60 m or 1.75 × 2.50 m). All sows had a jute bag as nesting material, which was placed in the piglet nest after farrowing and removed after 48 h. Piglets were provided with a drinking nipple, a round feeder (from d2 of age) and an additional jute bag hung at the side of the pen.

Piglets received an iron injection and tails were docked within 4 days of age following standard procedures on the farm. Males were not castrated. On day 19, pigs were vaccinated against mycoplasma and circo and PRRS (Porcine Reproductive and Respiratory Syndrome) virus. Litters were standardised to 14–15 piglets by cross–fostering within treatment, between 24 and 48 h after birth. Litter sizes and piglet mortality after cross–fostering (14.4 ± 0.07 and 0.84 ± 0.11, respectively) and litter size at weaning (13.6 ± 0.11) were similar for all treatments. Lights were on from 0730–1630 h, and an additional light between 0700 and 2000 h to check the pigs. Room temperature was 23 °C around farrowing and thereafter gradually decreased to 20 °C. In one of the farrowing rooms, floor heating was used for the piglets, and in the other, a heating lamp.

Postweaning

Piglets were weaned at 26.5 ± 0.2 days and moved to nursery rooms with 2.65 × 1.78 m pens. Piglets were kept in groups of 10 (five males and five females), n = 26 pens per treatment, until 5 weeks after weaning. Pigs within a weaner group originated from two to four litters and were always accompanied by at least one littermate. Piglets were selected based on sex and BW; the average weights of the selected piglets were representative of the weights of all piglets within a treatment, excluding the piglets with health

problems. Lights were on from 0700 to 2000 h. Room temperature was 26 °C immediately after weaning and decreased to 24 °C at 21 days after weaning.

Feeding system

Preweaning

The control system (Cs) was a conventional system with a raised feeder containing a drinking nipple for the sow. Sows were fed a pelleted (diameter 4 mm, length 10 mm) lactation diet (see Supplementary Table S1) twice a day, in amounts according to the farm's standard schedule (Supplementary Table S2).

In the family system (Fs, Fig. 1), sows were fed semi-*ad libitum* on a feeding plate (0.70 × 0.92 m). The front of the crate was widened to allow better access to the plate and piglets. Before farrowing, sows received 1 kg of feed a day on the plate at 0745 and 1545 h; after farrowing, this was 1–2 kg daily. Except for the day before and the day of farrowing, sows could get extra feed by operating a feeder mounted above the plate. The feeder consisted of a pipe with a pin at 60 cm height that could be pressed, after which 50 g of feed fell onto the plate. From the day after farrowing until d6, sows could get a maximum of 5 kg/day, on d7-8 7 kg/day, d9-10 10 kg/day and thereafter maximum 12 kg/day. The feeder was activated five times daily, at 0745, 1100, 1300, 1700 and 2100 h, and until the next activation, sows could obtain 30, 10, 10, 30 and 20% of their maximum daily ration, respectively. To announce activation of the feeder, 25 g of feed fell on the plate. If the maximum amount of feed until the next feeder activation had not been acquired by the sow, every hour, 25 g of feed was dropped. Piglets could eat together with the sow and were also provided a round 'play feeder', which was created from the standard feeder by attaching two cotton ropes and four chains, with at the end of each chain a piece of cotton rope, to stimulate exploration and foraging. Sows and piglets could drink from a drinker on the floor (Fig. 1). On top of the enrichment materials provided in the Cs, in the Fs, two ropes and a jute bag, hung at the fence within reach of the sow, were provided to allow piglets and sow to explore and play with these materials together.

Postweaning

Postweaning, piglets were fed *ad libitum* in a dry feed hopper with two feeding places and had continuous access to water via a drinking nipple. Piglets from the Fs system were provided with the drinker used in the farrowing room. In the first 4.5 days, piglets also received feed in the feeder from their farrowing pen. Enrichment consisted of a jute bag in the Cs system and additionally in the Fs system of a chain with a piece of wood, and two ropes attached to the side of the pen.

Dietary treatment

Preweaning

The sow diet in the family feed dietary treatment (Ff) was 99.95% the same as the sow diet in the conventional, control dietary treatment (Cf, Supplementary Table S1), with 0.05% of flavour (Luctarom, Lucta SA, Barcelona, Spain) added to allow pre- and postnatal transfer of flavour from the sow's diet to the piglets. Piglet feed composition is given in Supplementary Table S3. Cf piglets had a conventional creep feed from d2-d19. From d19, this feed was gradually replaced (in 2 days) by a conventional weaner diet (pellet diameter 4 mm, length 10 mm). Ff piglets had family piglet feed, containing the flavour and several ingredients from the sow's diet (barley, wheat, sunflower seed meal, wheat bran, soy hulls, vegetable fats and oils, rapeseed meal and fish oil, making up 30% of the feed composition), from d2-weaning, with varying pellet diameters (4 and 12 mm) and lengths (10–30 mm) to create dietary texture diversity. Piglets from the family system exposed to either dietary treatment (i.e. Fs-Cf and Fs-Ff piglets) could, additionally, also eat from the sow's feed via the feeding plate.

Postweaning

Concerning the conventional, control dietary treatment (Cf), piglets from the control system, i.e. Cs-Cf piglets, received conventional weaner feed in their 2-place feeder until d9 postweaning. Additionally, this feed was provided in the round feeder originating from the farrowing pen during the first 4.5 days postweaning. Piglets from the family system exposed to the control dietary treatment, i.e. Fs-Cf piglets, were given the same diets as Cs-Cf pigs in the 2-place feeder. However, in the round feeder, 50% sow feed and 50% weaner diet were provided to the Fs-Cf piglets to prevent an abrupt feed transition for the piglets that mainly ate sow feed preweaning. After d9, the diet was gradually (in 2 days) replaced by a nursery diet (pellet diameter 4 mm, length 10 mm).

Concerning the family feed dietary treatment (Ff), Ff piglets in both systems, i.e. Cs-Ff and Fs-Ff piglets, received family piglet feed until d9 postweaning (same as piglet feed provided prior to weaning). The Ff piglet feed provided in the round feeder contained the pellets with varied diameters (i.e. 10–30 mm) and length (i.e. 4 and 12 mm), but the same feed provided in the 2-place feeder consisted of pellets with 4 mm diameter and 10 mm length only as the larger and thicker pellets appeared to crumble in the feed delivery system, potentially restricting its outflow. After d9, the feed for Ff

Fig. 1. Features of the Family Feeding System: 1,2: Widened front of the crate with sow feeding system. The feeding system consisted of a pipe with pin that sows could press after which feed would fall onto a feeding plate that was also accessible to the piglets; 3: Drinker for sow and piglets placed at the left of the feeding plate; 4: Piglet 'playfeeder' created by attaching enrichment materials (two cotton ropes and four chains with a piece of cotton rope at the end) to a conventional piglet feeder; 5) Enrichment materials (two ropes and a jute bag) attached to the front of the crate for sow and piglets.

piglets was gradually (in 2 days) replaced by the conventional nursery diet (same as Cf pigs). Similar to Fs-Cf piglets, for the Fs-Ff piglets, the feed provided in the round feeder that was present during the first 4.5 days postweaning contained 50% sow feed, i.e. this was the same for all piglets from the family system regardless of dietary treatment.

Measurements

Sows

Weight, backfat (P2-spot (at the last rib), 6 cm left from median) and presence of shoulder ulcers were assessed after entry in the farrowing crate and at weaning. The amount of feed provided was measured at entry until farrowing, from farrowing until d7, d8-d14, d15-d21 and d22-weaning. Shoulder lesions were scored as (0) no damage; (1) lesion; (2) severe (deep) lesion. Less than 5% of the sows had severe lesions; therefore, scores 1 and 2 were combined into 'shoulder lesion'.

Piglets

Piglets were individually weighed within 24 h after birth, 1 day before weaning, and at d9 and d35 postweaning. Intake of piglet feed was measured during the lactation period, and from weaning-d9 and d9-d35 postweaning by collecting unconsumed feed at the end of each period. On the day before weaning, each piglet was classified as 'eater', 'non-eater' or 'doubtful', based on faecal structure and colour as previously described and validated (van Nieuwamerongen et al., 2015). Damage to ears (average of left and right) and tails and skin lesions at the head, front, middle and rear were scored according to a published protocol (Bus et al., 2023). For both tail and ear damage, scores >3 did not occur, and score 3 (medium wound) was combined with 2 (small wound) into 'wound'. Skin lesion scores of different body parts were summed. Faecal consistency (normal, pasty or watery, where pasty and watery were considered diarrhoea (van Nieuwamerongen et al., 2015)) was scored at d2, d5, d7, d9, d12, and d14. Percentages of piglets per group with diarrhoea were averaged until postweaning d9 (d2, d5, d7, d9) and thereafter (d12, d14).

In five batches (60 pens, 15 per treatment), frequencies of the behaviours listed in Table 1 were scored on d12 and d27 postweaning with behaviour sampling, using a tablet with the Pocket Observer 3.3 package (Noldus Information Technology, Wageningen, The Netherlands). Observations were done live in six sessions of 10 min per pen daily, in time blocks starting at 0800, 0925, 1050, 1245, 1410 and 1535 h. Distribution of the 10-min sessions over pens within blocks was balanced for treatment. In case of a pause of > 3 s or continuous performance of a behaviour > 30 s, a new occurrence was scored. At the start and end of each 10-min observation session, the proportion of pigs active (i.e. not lying) was scored.

Table 1
Ethogram used for behavioural observations of piglets.

Behaviour	Description
Play behaviour	
Individual play	Scamper (≥2 forwards hops in rapid succession), turn, flop, toss head, sliding and rolling individually
Social play	Nudging, gambolling, play fighting, scampering, running with at least one pen mate
Substrate play	Shaking of head while holding material (e.g. jute sack) that protrudes from mouth, or actively pulling
Tail biting	Nibbling, sucking or chewing tail of pen mate
Ear biting	Nibbling, sucking or chewing ear of pen mate
Biting other	Nibbling, sucking or chewing part of pen mate's body other than ears or tail
Belly nosing	Rubbing the belly of pen mate with up and down snout movements (≥3 up and down movements)
Rooting body	Rooting (up and down) part of pen mate's body except belly, or e.g. lifting another piglet's leg
Aggressive behaviour	Chasing, ramming, pushing, fighting with pen mate, including head knocking and biting
Mounting	Standing on hind legs while having front legs on pen mate's body

Statistical analyses

Statistical analyses were performed with SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Preweaning

One (Fs-Cf) sow was removed from the experiment due to health problems. Fixed effects of system (Fs vs Cs), dietary treatment (Ff vs Cf) and their interaction on BW loss, backfat loss and feed usage of the sows and average daily gain (**ADG**), weaning weight, average daily feed intake (**ADFI**) and lesion scores of the piglets (all averaged per litter), as well as percentage of (non)eaters within a litter were analysed with a mixed model with batch as random effect. Occurrence of sow shoulder damage was analysed with a generalised mixed model with binary distribution and logit link function, using the same effects.

Postweaning

Seven piglets (two Cs-Cf, four Cs-Ff, and one Fs-Cf) died after weaning. Fixed effects of system (Fs vs Cs), dietary treatment (Ff vs Cf) and their interaction on ADG, BW (averaged per pen), and percentage of pigs with diarrhoea and feed intake per pen were analysed with a mixed model with batch as random effect.

Proportion of pigs per litter with intact tails or ears, bite marks, or wounds were analysed with a generalised mixed model with binomial distribution, logit link function and multiplicative overdispersion parameter, using the same effects. As at weaning and on d35 postweaning, the number of piglets with tail wounds was 0 for at least one treatment group, the occurrence of tail wounds was transformed into a binary variable per piglet (0 = no tail wound; 1 = tail wound) and analysed with a Fisher's exact test.

Effects of feeding system (Fs vs Cs), dietary treatment (Ff vs Cf), day (d12 or d27) and their interactions on frequencies of behaviours were analysed with a generalised mixed model with Poisson distribution, log link function and multiplicative overdispersion parameter, with pen and batch as random effects. Only play behaviour was analysed with a linear mixed model after square root transformation as the generalised model did not converge. The percentage of scans spent active was also analysed with a linear mixed model with the same effects as described for the other behaviours. Preliminary analyses showed no interactions with day for any behaviour, so these were omitted from the final models and frequencies are presented in the results as average over both days. Data are expressed as means ± SEM, unless indicated otherwise. P-values below 0.05 were considered significant, and P-values between 0.05 and 0.10 a trend.

Results

The family system × dietary treatment interaction did not affect any variable, except the proportion of piglets with a tail wound at d35 postweaning, and the frequency of belly nosing (see below). The effects of system and dietary treatment will be discussed separately.

Preweaning performance

Sow BW and backfat loss did not differ between treatments, although BW loss tended to be lower in sows from the family sys-

tem (Fs) than in sows from the conventional, control system (Cs, $P < 0.10$, Table 2). At entry into the farrowing pen, no shoulder lesions were observed. At weaning, a lower proportion of Fs sows than Cs sows had shoulder damage ($P = 0.002$). Sow feed usage was higher in the Fs ($P < 0.0001$, all weeks). Dietary treatment did not affect sow performance, although feed usage tended to be lower for sows provided with the family feed (Ff dietary treatment) than for sows on the control diet (Cf) from d22-weaning ($P = 0.07$).

Preweaning piglet feed usage was lower in the Fs than in the Cs ($P < 0.0001$, Table 3). Fs piglets gained more weight than Cs piglets and were heavier at weaning (both $P = 0.02$). Proportion of Fs piglets scored as eater ($P = 0.003$) was higher, and as non-eater lower ($P = 0.0009$; remaining piglets were scored as 'doubtful') compared to Cs. The proportion of piglets with intact tails ($P < 0.0001$) and ears ($P = 0.004$) was higher in the Fs than in the Cs, and the proportion of piglets with bite marks on the tail ($P = 0.0002$) and ear wounds ($P = 0.004$) was lower. Fs piglets had lower lesion scores than Cs piglets ($P = 0.006$). Dietary treatment affected lesion score, with higher scores for Ff piglets than for Cf piglets ($P = 0.02$). No other effects of dietary treatment on preweaning performance were found.

Postweaning performance

Fs piglets had a higher BW at weaning than Cs piglets ($P = 0.0003$, Table 4). From weaning until d9, Fs piglets showed a lower ADG ($P = 0.02$), a higher feed intake ($P = 0.0003$) and were more likely to show diarrhoea ($P < 0.006$), whereas no effects of system on performance from d9-d35 were found, or on BW at d9 and d35. Dietary treatment did not affect ADG. A tendency for a higher feed intake from weaning until day 9 was found, however, for Ff piglets compared to Cf piglets. Feed intake from the round feeder that was provided during the first 4.5 days postweaning was for Cs-Cf 1.15 ± 0.05; Cs-Ff 1.35 ± 0.10; Fs-Cf 1.08 ± 0.08 and Fs-Ff 1.33 ± 0.08 kg/piglet. This amount did not differ between systems ($P = 0.61$), but was higher in Ff than in Cf piglets ($P = 0.002$). The Ff dietary treatment increased the percentage of piglets with diarrhoea until d9 postweaning ($P < 0.0001$) and tended to do so from d9-d35 ($P = 0.07$).

Both on d9 and d35, the proportion of piglets with intact tails ($P = 0.0005$ and $P < 0.0001$) was higher in the Fs than in the Cs, whereas the proportion of piglets with bite marks ($P = 0.0006$ and $P < 0.0001$) was lower (Table 5). On d35, the proportion of piglets with a tail wound was higher in the Cs-Cf treatment than in all other treatments (pairwise comparisons, $P < 0.05$). The proportion of piglets with intact ears was higher in the Fs than in the Cs, both on d9 ($P < 0.001$) and d35 ($P < 0.0001$). On d9, a lower proportion of Fs piglets than of Cs piglets were seen with bite marks on the ears ($P = 0.04$), and on d35, fewer Fs piglets had an ear wound ($P < 0.0001$). Dietary treatment did, apart from the combined effect with system on the proportion of piglets with a tail wound (see above), not affect tail and ear damage, except that on d9, the proportion of piglets with intact ears was lower ($P = 0.009$) and with an ear wound was higher for the Ff than for the Cf ($P < 0.05$). Body lesion score was affected by dietary treatment on d9, with higher scores for Ff than for Cf piglets ($P = 0.02$), and by system on d35, with lower scores for Fs than for Cs piglets ($P = 0.001$).

Postweaning behaviour

System affected the frequency of tail biting and ear biting behaviour, with Fs piglets showing less tail biting ($P = 0.034$) and ear biting ($P = 0.012$) than Cs piglets (Fig. 2). Additionally, Ff piglets showed more tail biting than Cf piglets (dietary treatment effect, $P = 0.047$). Belly nosing was affected by the system × dietary treatment interaction ($P = 0.009$), with higher frequencies in Fs-Ff than in Cs-Ff and Fs-Cf piglets ($P < 0.05$ for pairwise differences). Mounting was not affected by the system, but Ff piglets showed less mounting than Cf (dietary treatment effect, $P = 0.028$). Other behaviours were not influenced by system or dietary treatment.

Percentages of scan sampling observations during which piglets were active (Cs-Cf: 47.5 ± 2.4%; Cs-Ff: 47.8 ± 2.1%; Fs-Cf: 44.8 ± 1.6%; Fs-Ff: 47.8 ± 2.1%) were not affected by system ($P = 0.44$) or dietary treatment ($P = 0.53$). Frequencies of tail biting ($P = 0.0004$), ear biting ($P = 0.011$), biting other body parts ($P < 0.0001$), and belly nosing ($P = 0.005$) increased from d12 to d27, whereas aggression ($P < 0.0001$), mounting ($P = 0.0002$) and activity decreased ($P < 0.0001$), and play behaviour and rooting body were not affected by day (data not shown).

Discussion

The effects of a family feeding system (Fs) and dietary treatment with family feed (Ff) compared to a conventional system (Cs) and feed (Cf) were investigated. The Fs stimulated ADG preweaning, reduced the number of suckling piglets characterised as non-eaters and enhanced feed intake in the first 9 days after weaning. However, in this period, a lower ADG was found for Fs piglets compared to Cs piglets, possibly related to the higher percentage of Fs piglets with diarrhoea. Over the whole experiment up till 35 days postweaning, no effects of the Fs on ADG were found. The Fs did, however, decrease damaging behaviour and wounds as compared with the Cs on the long term. The dietary

Table 2
Effect of feeding system (Control system or Family feeding system) and dietary treatment (Control feed or Family feed) on performance of lactating sows.

	Control feeding system		Family feeding system		*P*-values		
Variable	Control feed	Family feed	Control feed	Family feed	System	Feed	S × F[1]
Litter size at weaning	13.7± 0.2	13.7 ± 0.2	13.4 ± 0.2	13.6 ± 0.3	0.31	0.50	0.74
BW loss (kg)[2]	34.2 ± 3.2	40.1 ± 3.5	31.8 ± 4.4	32.0 ± 3.4	0.098	0.35	0.35
Backfat loss (mm)[2]	3.5 ± 0.5	3.4 ± 0.3	3.2 ± 0.5	3.8 ± 0.4	0.66	0.76	0.46
Shoulder damage (% sows)	28.0 ± 9.2	42.3 ± 9.9	4.2 ± ± 4.2	3.9 ± 3.9	0.002	0.73	0.65
Feed usage (kg/d)							
Entry[3] – farrowing	2.50 ± 0.04	2.45 ± 0.07	4.90 ± 0.16	5.09 ± 0.20	<0.0001	0.61	0.36
Farrowing – d7	3.02 ± 0.08	3.04 ± 0.06	4.54 ± 0.15	4.78 ± 0.22	<0.0001	0.34	0.42
d8 – d14	6.23 ± 0.16	6.18 ± 0.20	7.82 ± 0.25	7.62 ± 0.31	<0.0001	0.58	0.74
d15 – d22	7.63 ± 0.23	7.32 ± 0.32	9.62 ± 0.27	9.08 ± 0.28	<0.0001	0.12	0.67
d22 – weaning	9.58 ± 0.29	9.15 ± 0.34	11.89 ± 0.42	11.29 ± 0.33	<0.0001	0.07	0.72

[1] S × F = System × Feed interaction.
[2] Values at weaning minus values at entering farrowing pen.
[3] Entry 1 week before expected farrowing date.

Table 3
Effect of feeding system (Control system or Family feeding system) and dietary treatment (Control feed or Family feed) on preweaning performance of piglets.

	Control feeding system		Family feeding system		*P*-values		
Variable	Control feed	Family feed	Control feed	Family feed	System	Feed	S × F[1]
ADG (g/d)	224 ± 4.9	221 ± 4.8	236 ± 5.6	234 ± 6.2	0.02	0.56	0.92
BW weaning (kg)	7.3 ± 0.15	7.2 ± 0.14	7.6 ± 0.18	7.6 ± 0.17	0.02	0.88	0.58
Piglet feed (kg/pig)	0.47 ± 0.05	0.45 ± 0.05	0.29 ± 0.04	0.27 ± 0.03	<0.0001	0.62	0.93
Eaters (%)[2]	59.8 ± 5.0	59.0 ± 4.9	70.8 ± 4.6	75.3 ± 3.5	0.003	0.68	0.56
Non-eaters (%)[2]	22.4 ± 3.8	22.0 ± 4.3	12.5 ± 2.9	9.3 ± 2.3	0.0009	0.59	0.68
Tail damage (%)[2]							
Intact tail	86.5 ± 2.7	86.9 ± 2.4	96.7 ± 1.2	93.8 ± 1.9	<0.0001	0.55	0.43
Bite marks tail	12.7 ± 2.5	12.7 ± 2.5	3.3 ± 1.2	6.2 ± 1.9	0.0002	0.49	0.49
Tail wound[2]	0.8 ± 0.5	0.4 ± 0.4	0.0 ± 0.0	0.0 ± 0.0	0.24	1.00	–[3]
Ear damage (%)[2]							
Intact ears	38.5 ± 4.7	36.2 ± 4.3	52.5 ± 3.1	45.8 ± 4.3	0.004	0.27	0.60
Bite marks ears	50.0 ± 4.4	50.0 ± 4.3	43.5 ± 2.7	46.5 ± 3.8	0.20	0.70	0.70
Ear wound	11.5 ± 2.4	13.8 ± 2.5	3.8 ± 1.2	7.7 ± 1.7	0.004	0.10	0.68
Body lesion score	1.4 ± 0.1	1.7 ± 0.1	1.1 ± 0.1	1.3 ± 0.1	0.006	0.02	0.69

Abbreviations: ADG = average daily gain.
[1] S × F = System × Feed interaction.
[2] Measured day before weaning.
[3] Analysed with Fisher's exact test; no significant pairwise differences.

Table 4
Effect of feeding system (Control system or Family feeding system) and dietary treatment (Control feed or Family feed) on postweaning performance in piglets.

	Control feeding system		Family feeding system		*P*-values		
Variable	Control feed	Family feed	Control feed	Family feed	System	Feed	S × F[1]
BW (kg)							
weaning	7.6 ± 0.1	7.5 ± 0.1	7.9 ± 0.1	8.0 ± 0.1	0.0003	0.91	0.23
d9	9.7 ± 0.2	9.6 ± 0.1	9.7 ± 0.2	10.0 ± 0.1	0.11	0.43	0.19
d35	23.4 ± 0.5	23.5 ± 0.3	23.1 ± 0.4	23.6 ± 0.4	0.84	0.49	0.59
ADG (g/pig/day)							
weaning – d9	233 ± 9	237 ± 9	211 ± 10	226 ± 11	0.02	0.14	0.37
d9 – d35	523 ± 15	528 ± 12	511 ± 12	518 ± 10	0.28	0.59	0.95
ADFI (g/pig/day)							
weaning – d9	278 ± 9	295 ± 11	311 ± 8	327 ± 13	0.0003	0.07	0.91
d9 – d35	786 ± 22	792 ± 17	765 ± 17	775 ± 17	0.21	0.60	0.93
Diarrhoea (% of pigs)							
weaning – d9	14.6 ± 1.7	19.3 ± 2.2	16.7 ± 1.5	24.7 ± 2.3	0.006	<0.0001	0.33
d9 – d14	16.9 ± 2.3	19.2 ± 2.6	14.7 ± 2.4	19.4 ± 2.4	0.66	0.07	0.58

Abbreviations: ADG = average daily gain; ADFI = average daily feed intake.
[1] S × F = System × Feed interaction.

treatment did not affect preweaning performance, but the Ff tended to stimulate postweaning feed intake. A higher proportion of Ff piglets had diarrhoea, however, compared to Cf piglets in the first 9 days after weaning, with no effect on ADG.

Effects of the family feeding system

Sow and piglet performance before weaning

Fs sows could obtain small portions of feed throughout the day, and their feed usage was considerably higher than that of Cs sows. Offering small amounts of feed frequently over the day has been shown to increase sow feed intake during lactation (e.g., Libal and Wahlstrom, 1983). Yet, no system effects on backfat loss were found, and only a tendency for a lower BW loss in the Fs sows, but it has been reported that a higher feed consumption in lactating sows may increase milk production and thereby benefit piglet growth rather than sow body condition (van Wagenberg et al., 2006; Strathe et al., 2017). The higher sow feed usage might not (only) reflect a higher feed intake by the sow, but also feed consumption by piglets, and spillage. Despite the absence of strong effects of system on sow BW and backfat loss, the occurrence of shoulder ulcers, which is usually strongly related to body condition (Rioja-Lang et al., 2018), was profoundly lower in the Fs sows. The presence of shoulder ulcers has been shown to affect the behaviour of sows, including maternal behaviour (Larsen et al., 2015), and may thus have influenced piglet performance as well. Changes in sow behaviour might partly explain this effect, as Fs sows likely stood up more often to operate the feeder and had, due to the widened cage front, more freedom of movement and variety in lying positions. Little is known, however, about the influence of sow behaviour on development of shoulder lesions (Rioja-Lang et al., 2018). Although the Fs was mainly designed to promote piglet performance around weaning, it may also affect the performance and welfare of sows, which merits further research.

The percentage of eaters was higher in the Fs than in the Cs, and the percentage of non-eaters was only half (11%) of that in the Cs (22%). This indicates that the Fs successfully stimulated feeding in suckling piglets. Given the profoundly lower intake of piglet feed in the Fs than in the Cs, Fs piglets presumably ate substantial amounts of sow feed, confirming indications that piglets prefer

Table 5
Effect of feeding system (Control system or Family feeding system) and dietary treatment (Control feed or Family feed) on damage to tails, ears and body lesions postweaning in piglets.

	Control feeding system		Family feeding system		*P*-values		
Variable	Control feed	Family feed	Control feed	Family feed	System	Feed	S × F[1]
Tail damage d9 (% of pigs)							
Intact tail	86.1 ± 3.7	81.3 ± 4.9	91.9 ± 2.4	93.1 ± 2.9	0.0005	0.64	0.30
Bite marks tail	12.7 ± 3.3	18.7 ± 4.9	7.7 ± 2.2	6.5 ± 2.8	0.0006	0.51	0.22
Tail wound	1.2	0.0	0.4	0.4	1.00	0.37	– [2]
Tail damage d35 (% of pigs)							
Intact tail	75.3 ± 4.8	77.7 ± 4.7	93.7 ± 1.7	89.6 ± 2.9	<0.0001	0.40	0.17
Bite marks tail	19.7 ± 3.8	20.7 ± 4.3	6.3 ± 1.7	10.0 ± 2.9	<0.0001	0.20	0.32
Tail wound	5.0[a]	1.5[b]	0.0[b]	0.4[b]	0.0001	0.09	* [3]
Ear damage d9 (% of pigs)							
Intact ears	20.4 ± 5.5	10.4 ± 4.2	29.7 ± 6.6	22.7 ± 6.2	0.001	0.009	0.26
Bite marks ears	62.6 ± 5.0	65.4 ± 4.1	54.6 ± 5.1	57.3 ± 4.9	0.04	0.49	0.95
Ear wound	16.9 ± 3.8	24.4 ± 3.8	15.0 ± 3.2	20.0 ± 4.0	0.33	<0.05	0.79
Ear damage d35 (% of pigs)							
Intact ears	31.4 ± 6.6	30.7 ± 6.3	45.5 ± 5.8	51.5 ± 6.3	<0.0001	0.62	0.49
Bite marks ears	50.6 ± 5.6	50.5 ± 4.4	49.5 ± 5.5	41.5 ± 5.0	0.18	0.34	0.35
Ear wound	17.7 ± 5.1	18.5 ± 4.7	4.6 ± 1.8	6.9 ± 2.8	<0.0001	0.40	0.52
Body lesion score							
d2	1.7 ± 0.2	1.8 ± 0.2	1.4 ± 0.2	1.6 ± 0.2	0.06	0.22	0.62
d9	1.5 ± 0.2	1.8 ± 0.2	1.3 ± 0.2	1.7 ± 0.2	0.33	0.02	0.84
d35	2.1 ± 0.2	2.3 ± 0.3	1.6 ± 0.2	1.7 ± 0.2	0.001	0.32	0.67

[1] S × F = System × Feed interaction.
[2] Analysed with Fisher's exact test; no significant pairwise differences.
[3] Analysed pairwise with Fisher's exact test: *Significant pairwise differences; [a,b] Values within a row with different superscripts differ significantly at $P < 0.05$.

their mother's diet (Oostindjer et al., 2011a). As the current study is a system comparison, it is not possible to pinpoint exactly whether and to what extent each Fs feature contributed to the reduced proportion of non-eaters. Likely, facilitating the opportunity to forage with the sow was an important stimulus, in line with studies in test settings demonstrating that piglets which are allowed to observe their eating mother show increased feed intake (Oostindjer et al., 2011a) and reduced food neophobia (Oostindjer et al., 2011d). Other contributing features might be the extra enrichment, stimulating exploration jointly with the sow, and the play feeder, stimulating foraging in a playful manner. Two previous studies reported that piglets visit such a feeder more frequently (Kuller et al., 2010) or spend more time on feeder visits (Middelkoop et al., 2019b), although only one of the studies found an effect on preweaning growth (Kuller et al., 2010) and on the proportion of piglets per litter visiting the feeder (Middelkoop et al., 2019b). Presumably, it was the combination of all features of the Fs that promoted feeding behaviour in Fs piglets. Whether the opportunity to drink together with the sow stimulated water intake by the Fs piglets and thereby contributed to enhanced feeding is not known, but it has been reported that provision of water to suckling piglets stimulates growth preweaning (Cunningham and Friend, 1966) and that eating and drinking time during the first two postweaning days are positively associated (Dybkjær et al., 2006).

We cannot estimate to what extent the presumed higher feed intake of Fs suckling piglets contributed to their enhanced ADG and slightly higher weaning weight, as intake of sow feed by the piglets could not be distinguished from that by the sow. A potentially higher milk production due to a higher feed consumption by the Fs sows could well be another factor accounting for the enhanced preweaning performance of Fs piglets (e.g., Strathe et al., 2017).

Piglet performance after weaning

Feed intake in the first 9 days postweaning was higher for Fs than for Cs piglets. Given the higher proportion of eaters in the Fs, this aligns with studies demonstrating improved postweaning feed intake in piglets identified as eaters preweaning (e.g., Bruininx et al., 2002a). However, whereas previous studies report a concomitant enhanced postweaning ADG in preweaning eaters (e.g., Bruininx et al., 2002a; Sulabo et al., 2010), in our study, Fs piglets showed a lower ADG in the first nine postweaning days compared to Cs piglets. In this early postweaning period, the percentage of piglets with diarrhoea was also higher in the Fs than in the Cs, which might be one of the factors limiting ADG in Fs piglets. This seems in contradiction with studies reporting improved gut (microbiota) maturation at weaning (Choudhury et al., 2021) and improved postweaning gut health (see Jayaraman and Nyachoti, 2017 for review) in preweaning eaters, and a lower prevalence of diarrhoea postweaning in good preweaning eaters (Carstensen et al., 2005). However, the effects of postweaning feed intake on gut functioning are equivocal. Some studies demonstrate that a low feed intake in weaners is associated with poor intestinal health (e.g., Madec et al., 1998), whereas others find limited effects of postweaning feeding patterns (e.g., Bruininx et al., 2002b). A recent study indicates that a (too) high feed intake in the first days after weaning may even increase the probability of diarrhoea, possibly caused by poor protein digestibility and/or high concentrations of antinutritional factors (Engelsmann et al., 2023). It is unknown whether the enhanced feed intake of Fs piglets in the first nine postweaning days per se increased the proportion of piglets with diarrhoea. Importantly, in our study, Fs piglets could also ingest sow feed after weaning, as the round feeder that they were provided with for 4.5 days (on top of a large 2-place feeder containing piglet feed) contained 50% sow feed, to prevent a large transition in feed type in piglets that had mainly selected their mother's diet before weaning. Recordings of feed usage indicate that during the first postweaning days, piglets ate almost solely from this feeder, meaning that the Fs piglets' diet consisted of a profound amount of sow feed, of which the composition is suboptimal for weanling piglets. This likely contributed to the higher number of Fs piglets seen with diarrhoea, which could, in turn, have resulted in a lower ADG in these piglets in the first 9 days

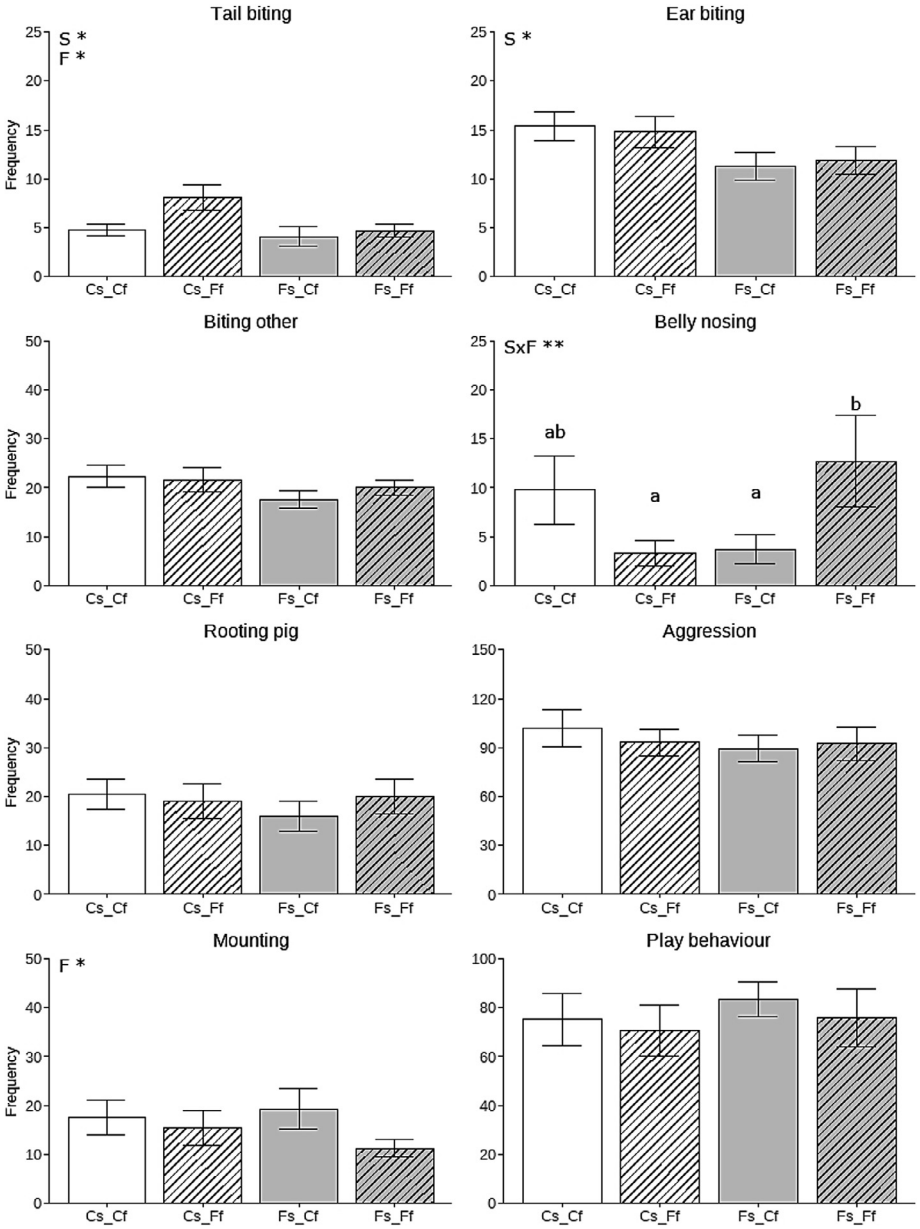

Fig. 2. Behaviours (in frequency per group of piglets per hour) of piglets postweaning. Piglets were raised in a Control system (Cs) or a Family feeding system (Fs) and exposed to a dietary treatment in which they were fed either Control feed (Cf) or Family feed (Ff). Significant effects of system (S), dietary treatment (F) and their interactions are indicated: $^{*}P < 0.05$; $^{**}P < 0.01$. ^{a,b} Regarding interaction effects, values with different letters differ significantly at $P < 0.05$.

postweaning compared to Cs piglets. As Fs piglets started with a higher weaning weight, and ADG from d9-d35 did not differ from that of Cs piglets, BW on day 35 postweaning was not affected by system, reflecting a poorer performance in Fs piglets given their higher weaning weight. Thus, in hindsight, likely more sow feed was offered to the Fs weanling piglets than they could handle for optimal gastrointestinal functioning. Possibly, offering a much smaller amount of sow feed on top of the weaner diet would have been enough to prevent neophobia of this new diet without compromising piglet performance. Finally, we cannot exclude that the floor drinker provided to the Fs piglets may have influenced their performance, even though it was rarely soiled, as water quality in nipples has been reported to be better (Boe and Kjelvik, 2011).

Behaviour and body damage

Although tail wounds were rare before weaning, several piglets showed bite marks at weaning, confirming that chewing on tails already starts in the farrowing pen (e.g. Ursinus et al., 2014). The proportion of Fs piglets with bite marks and/or wounds on tails and ears was considerably lower than that of Cs piglets, both before and after weaning. Accordingly, a lower frequency of tail and ear biting behaviour was seen in Fs piglets postweaning up till the end of the experiment. The reduction in these damaging behaviours could be related to the provision of extra enrichment materials in the Fs, as jute bags and to a lesser extent, ropes may reduce tail biting (Buijs and Muns, 2019). Previous studies also point to a beneficial effect of provision of a play feeder preweaning (Middelkoop et al., 2019a) or loose housing of the sow, on piglet

behaviour postweaning, the latter suggesting that enhanced possibilities to interact with the sow may also be important for behavioural development (Oostindjer et al., 2011c). Body lesion scores, which reflect aggression, measured at 2, 9 and 35 days postweaning were very low, which is expected in settled social groups. Nevertheless, at weaning and at d35 postweaning, Fs piglets had lower lesion scores.

Effects of the family feed

The main feature of the Ff to putatively promote piglet performance around weaning was the addition of the same flavours to the sow and piglet diets, with additionally a variety in pellet sizes, including large pellets. The Ff did not affect sow performance or preweaning piglet performance. In a previous study, the provision of larger pellets slightly stimulated feed intake in the first 10 days of lactation, but did not enhance overall preweaning feed intake or growth as its beneficial effects were most pronounced after weaning (Van den Brand et al., 2014). Also, for the flavour associative learning feature of the Ff, advantages for piglet performance were mainly expected after weaning. Although suckling piglets prefer flavour cues from the diet fed to their mother during late gestation (Oostindjer et al., 2009; Figueroa et al., 2013) or during late gestation and lactation (Oostindjer et al., 2009) over control flavours as demonstrated in olfactory choice tests, this does not necessarily lead to a preference for similarly flavoured creep feed (Figueroa et al., 2013, 2019b) nor a higher feed intake before weaning (Blavi et al., 2016). It has been suggested that flavoured creep feed cannot compete with the hedonic properties of flavoured sow milk, as the postingestive benefits of its ingestion are less clear (Blavi et al., 2016). Moreover, in humans, even sensory specific satiety has been reported, with infants exposed to flavoured mother's milk temporarily showing a lower consumption of a similarly flavoured cereal (Mennella and Beauchamp, 1999). Offering a creep feed during lactation containing flavours from the maternal peripartum diet does therefore not benefit preweaning piglet performance. After weaning, however, positive effects of prenatal and/or perinatal associative flavour learning on piglet feed consumption and growth (Oostindjer et al., 2010; Blavi et al., 2016), diarrhoea (Oostindjer et al., 2010), behaviour and stress level (Oostindjer et al., 2010, 2011b) have been reported. Also, associative flavour learning via the sow's diet solely during lactation was found to enhance piglet performance postweaning in a recent study, although these effects were possibly confounded by a higher feed intake of the sows offered the flavoured diet and, consequently, a higher piglet weaning weight (Justino et al., 2023). The beneficial impacts of associative flavour learning on weanling piglet performance are likely merely related to stress reduction. The presence of the familiar flavour may reduce neophobia of the new, postweaning situation, and its association with positive pre-and postnatal conditions and post-ingestive effects may further reduce weaning stress (Oostindjer et al., 2011b; Oddo et al., 2016).

In the present study, a tendency of a higher feed intake in the first nine postweaning days was found in piglets fed the Ff diet, mainly due to a significantly higher feed consumption from the feeder transferred from the farrowing pen. However, in contrast with previous studies, the expected beneficial effects on piglet growth or behaviour were not found, and the Ff even increased the percentage of piglets with diarrhoea in the first nine postweaning days and tended to do so up to day 35. There might be different reasons for the absence of broad beneficial effects on postweaning piglet performance. Firstly, it has been suggested that adding the same flavour from the sow's diet to the creep feed might not only fail to increase preweaning feed intake, but even lead to extinction of flavour learning, thereby annihilating the effects of prenatal associative learning (Blavi et al., 2016; Figueroa et al., 2019b). In support of this, it has been demonstrated that piglets which had been offered a non-flavoured creep feed before weaning preferred the flavour of their mother's diet at weaning, whereas this was not the case in weanling piglets that had been offered a creep feed with the same flavour during lactation (Blavi et al., 2016). Therefore, Blavi et al. (2016) recommended to use non-flavoured creep feed when using associative flavour learning, thus adding the flavour to the sow's and weaner piglet diets only. Another option is that the feed intake by Ff piglets did not benefit ADG because its effect was nullified by the higher incidence of diarrhoea in Ff piglets as compared to Cf piglets. This higher diarrhoea incidence might be due to the higher fibre content, among others, of the Ff piglet feed as it contained, apart from the flavour, also several ingredients from the sow's diet. In contrast with the effects of the family system, however, the high incidence of diarrhoea was not accompanied by a decrease in postweaning growth in Ff piglets. A limitation of our study is that, given the use of the artificial flavour in the Ff diet only, we cannot fully disentangle the effects of the family feed strategy from those of this flavour per se. The artificial flavour added to the Ff diet may, irrespective of flavour transfer, have affected palatability and, in turn, feed intake. The lack of an effect of diet on preweaning intake of piglet feed and sow feed usage and the trend for a higher usage of the control diet from day 22 until weaning in the sows do not suggest a preference for the Ff diet per se. However, the effect of palatability on feed consumption is complex, warranting the use of measurements specifically addressing palatability in addition to intake measurements in future studies (e.g. Figueroa et al., 2019a), as well as the inclusion of flavours in control groups.

On day 9 postweaning, a larger proportion of Ff piglets showed ear wounds compared to Cf piglets, and on this day, also their body lesion scores were higher. Ff piglets also showed tail biting behaviour more frequently. This did, however, not lead to more tail damage; in fact, on day 35, the Ff decreased the proportion of pigs with a tail wound in the Cs system. Possibly, the higher fibre content of the Ff piglet feed as compared with the Cf piglet feed may have exerted an effect on damaging behaviours, although the impact of dietary fibres on these behaviours is not consistent and may be age-dependent. While a fibre-rich diet has been found to reduce the occurrence of tail wounds in fattening pigs (van der Peet-Schwering et al., 2017), in weanling pigs, either no (van der Peet-Schwering et al., 2017; Naya et al., 2019; Honeck et al., 2020) or even a negative effect (Chou et al., 2020) on damaging behaviour was found. It is impossible to generalise the effects of fibre-rich diets on weanling piglets, as these can, on the one hand, benefit gut health (Molist et al., 2014), but might, depending on the type of fibre and inclusion level, also cause 'gastrointestinal discomfort', which has been suggested to increase the risk of damaging behaviours (Taylor et al., 2010; Boyle et al., 2022).

It is not fully clear why belly nosing was observed most in the Fs-Ff piglets, as this behaviour is generally seen as redirected suckling behaviour, and has been linked to disturbed feeding and drinking behaviour and insufficient feed intake in weaners (see Widowski et al., 2008). Others found, however, no effect of feed restriction on belly nosing (Tucker et al., 2010). It is also unclear why the Ff piglets showed less mounting than piglets on the Cf diet; this effect cannot be explained by a difference in activity levels as these were not affected by system or diet.

Conclusion

In conclusion, the family feeding system, allowing piglets to eat with the sow in a playful manner, increased the number of eaters and growth preweaning, and reduced damaging behaviour and wounds on the longer term. However, the family system increased postweaning diarrhoea, possibly because weanling piglets were

still allowed to eat some sow feed, and did not enhance postweaning growth. The dietary treatment with family feed tended to increase postweaning feed intake, but also diarrhoea, possibly due to its higher fibre content. Using strategies that meet the natural behaviour of pigs seems promising to enhance piglet welfare around weaning, but further adjustment to the nutritional needs of weanling piglets is needed.

Supplementary material

Supplementary Material for this article (https://doi.org/10.1016/j.animal.2025.101610) can be found at the foot of the online page, in the Appendix section.

Ethics approval

Not applicable.

Data and model availability statement

None of the data were deposited in an official repository. Information can be made available from the authors upon request.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) did not use any AI and AI-assisted technologies.

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Declaration of interest

None.

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