Effects of feed choices on growth, health, incidence of diarrhoea and damaging behaviour during the weaning period of piglets

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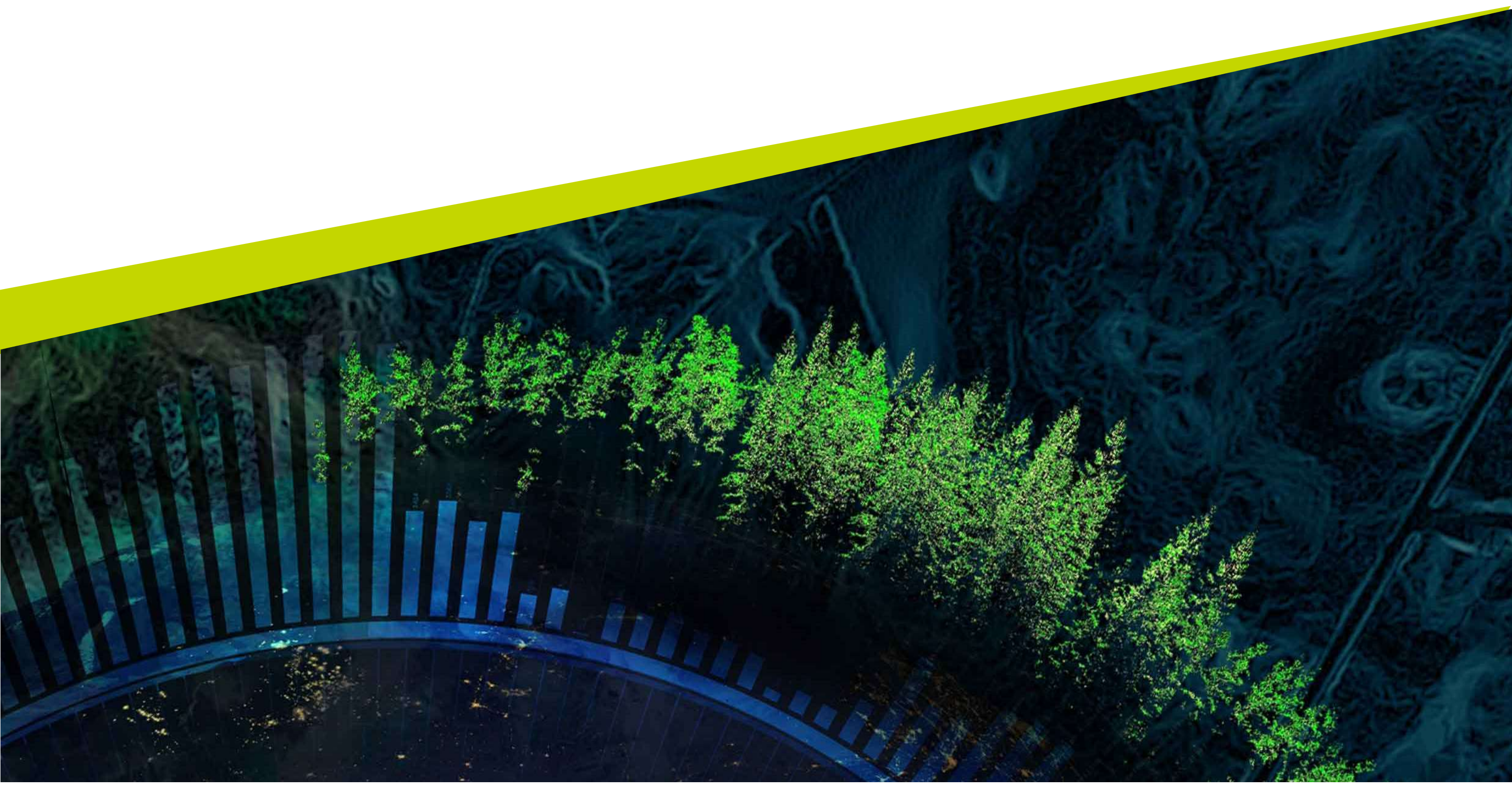

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Abstract

The Swedish agenda 2030 promotes a more sustainable agriculture (Nilsson 2017). In that frame, agricultural research about animal behaviour, health and welfare is critical for reaching the evocated goals. In pig farming, one of the main health and welfare concerns occurs before and after piglets' weaning (Kim et al. 2024; Wallgren et al. 2019; Westin 2004; Huting et al. 2021). This research aims to evaluate the effects of feed choice on health, weight gain, damaging behaviours and the incidence of diarrhoea before and after weaning. For this, an applied experiment has been performed at Funbo Lövsta farm, the experimental farm of the Swedish University of Agricultural sciences. Three groups of piglets were set: a choice group accessing five different feeds in five different playful feeders in an extra pen, a no-choice group accessing their usual creed-feed in a usual feeder in an extra-pen, and a control group raised according to conventional Swedish practices. Piglets from the choice and no-choice treatments could work for 2 minutes access to the extra-pens by pushing a weighed door. This was set progressively heavier with each experimental session day according to a fixed ratio (Kagel et al. 1995). They were driven back in their pen between these two-minutes exposition for refilling the feeders, and this was repeated 20 times. As soon as this task was done, piglets were exposed again to the treatment. 153 piglets from fifteen litters were included in this study, five litters per treatment groups. Data was collected manually, then stored on Microsoft Excel (2016) files. The statistical analyses were performed on Rstudio 4.4.2 (2024). Concerning damaging behaviour, certain kinds of skin lesions appear significantly less often within the choice and no-choice treatments compared to the control group. The hypothesis was: "The freedom of choice will promote growth and health during the weaning period, while reducing damaging behaviours". In the results, damaging behaviour is the only point showing significative improvements with the treatment groups. For weights, the control group was the heaviest at weaning and at seven weeks old. Results do not allow to support the hypothesis. There could be more piglets included in this research because the experiment was not completed by the time of writing this thesis. Maybe including this last animal batch in the statistical sample could improve the significance of some results and making more stated conclusions.

Abbreviations

ADG – Average Daily Gain (g/day)

Contents

1 Introduction

1.1 Issues in modern pig farming

A recent increase

Between 1975 and 2021, the number of pigs globally raised has increased from 700 million to almost a billion pigs (Kim et al. 2024). The reason of this rise was the growing demand of pork. This global demand grew from 63,5 million tons to 113 million tons of pork between 1990 and 2022 (Kim et al. 2024). With such a rise, the pig and pork industries have faced challenges to reach the quantitative and qualitative demand requirements.

Research sectors

In 2023, the American Society of Animal Science held conferences. They have shown that most of studies lately run in the global pig sector are about nursery. More specifically, they are about piglet enteric diseases and diarrhoea after weaning (Kim et al. 2024). That reflects the field of issues that modern pig farming is facing with. Hence, many papers were written about piglet feeding and nutrition in the aim to improve gut health (Kim et al. 2024). The final goal being to increase the growth efficiency, by improving the nutrient utilisation. On another hand, many other factors influence enteric diseases and diarrhoea after weaning. One of them is stress resilience (Wallgren et al. 2019). It can be improved by enriching piglets' environment before and after weaning. The aim being to perform a smoother behavioural transition over weaning (Wallgren et al. 2019; Westin 2004). However, stress resilience is still a main issue after weaning (Huting et al. 2021). That means current enrichment legislation doesn't seem to reach pigs' requirements for expressing their natural behaviour (Godyń et al. 2019). For instance, it is mandatory to provide one material for manipulation (Godyń et al. 2019). But most of the materials allowed don't allow pigs to express their whole behavioural range or aren't compatible with their farm conditions. Actually, optimal material must be manipulable, chewable, edible and investigable (Godyń et al. 2019). For instance, straw is optimal but doesn't always fit in pig farm with a lot of gratings (Godyń et al. 2019). Indeed, suboptimal materials should be used in complement of each other's. However, the legislation isn't accurate enough yet (Godyń et al. 2019). Ways to improve piglets' stress resilience still have to be found, and it seems that environment enrichment still has to be improved.

1.2 The antagonism of pig feeding behaviour and modern pig feeding

Piglets' feed choice and foraging

Feed choice

In modern Swedish pig production, piglets' weaning is at 5 weeks of age (Thomsson et al. 2016). In contrast, the natural pigs' weaning is a process gradually occurring over several weeks (Van Kerschaver et al. 2023). It ends between the 14^{th} and the 18^{th} week of age. Thereby, in modern farming, piglets are weaned without being used to consume other feed than milk or milk replacers (Huting et al. 2021). This situation leads to food intake reductions. Beside the feed changes of weaning, the new environmental and social conditions stress out piglets (Parois et al. 2022). These conditions impact piglets' resilience by inducing welfare problems (Korte et al. 2007). Some of them are post-weaning diarrhoea, the increase of medication use, decreasing performances, and damaging behaviour like fighting, tail biting (Parois et al. 2022, Korte et al. 2007 and, Pluske et al. 1997). For counterbalancing these phenomena, a solution is exposing piglets to feed choice (Hintze & Yee 2023). This improves their control on environment for a better health and animal welfare. Feed choice stimulates piglets' pleasure by reaching their agency needs (Špinka 2019). This also increases their feed intake (Clouard & Val-Laillet 2014). But it doesn't work with flavour choice (Middelkoop et al. 2018). In Middelkoop et al. (2018), piglets from 16 to 22 days of age exposed to flavour novelty ate 225g of feed per litter per day. In the same experiment, another group with feed choice ate 350g of several feeds in average. More, exposing young piglets to a bigger range of feed with dietary fibre improves their gastrointestinal tract development and their gut microbiota development (Choudhury et al. 2021). Piglets consuming such a feed variety tend to have bigger pancreas and longer total intestinal tracts (Choudhury et al. 2021). They are hints of an earlier digestive development. Another study has shown that dietary diversity before weaning leads to a decrease of body lesions four hours after weaning (Middelkoop 2020). The results of Middelkoop (2020) have shown that litters of 13 to 15 piglets exposed to a diverse diet before weaning had a mean of 15,8 body lesions per litter, whereas piglets with a monotonous diets had 24,1 body lesions per litter. Thereby, feed choice is a track to follow for improving piglets' environment enrichment. However, sow milk is the main feed of piglets before weaning (Tkacheva & Medvedev 2021). Correlations have been shown between the incidence of carpal abrasion and longer suckling time (Mouttotou & Green 1999). More, the heavier are piglets, the bigger is the incidence of these knee abrasions (Mouttotou & Green 1999). Nevertheless, knee abrasions are a lack in animal welfare and can be sources of infections for piglets.

Foraging

Foraging is part of natural pig's behaviour (Stolba & Wood-Gush 1989). In the wild, 52% of pigs' time is spent foraging a wide range of different feed. However, modern pig farming doesn't rely on it and infringe pigs' welfare (Young et al. 1994). Nowadays, diets are standardised and quickly consumed without foraging activities (Young et al. 1994). This natural behaviour has effects concerning nutrient intakes (Day et al. 1996). Day et al. (1996) states that pigs acquire nutritional information while foraging and are able to choose feeds depending on the nutrients they need or prefer. Yet, foraging is also interesting from a behavioural point of view (de Jonge et al. 2008). For instance, exploring and searching are known for being rewarding activities (de Jonge et al. 2008, Young et al. 1994). Moreover, hampering piglets' natural behaviours can induce a low stress resilience, altering brain plasticity (Rault et al. 2018), increasing anxiety (Sampedro-Piquero et al. 2014), increasing damaging behaviours (van de Weerd & Ison 2019), leading to some inabilities to recover and cope with challenges (Parois et al. 2022). As a solution, setting playful feeders in the piglets' pen before weaning significantly reduces the mean count of body lesions (Middelkoop 2020).

Foraging helps the digestive tract development, improves digestions and piglets' appetite (Middelkoop 2020). In Middelkoop (2020), piglets foraging their diet in a sand substrate tend to have a better average daily gain between day 2 and 5 after weaning compared to piglets no exposed to sand substrate in their feeder (309g/d for the group with substrate and 283g/d for the group without). Moreover, playful feeders have shown efficacity for lowering the prevalence of diarrhoea during the two weeks after-weaning (Middelkoop 2020). Results show 16,7% of pen diarrhoea incidence with playful feeders, and 61,1% for pens without ($p<=0,01$).

Measuring motivation

Studies have been conducted on a few species about animal motivation, including pigs (Jackson et al. 1999; Olsson et al. 2002; Kirkden & Pajor 2006). Most of them studied the feeding pattern of animals. Various methods are used for investigation, and one of them consists in making animals pushing a weighed door for accessing any kind of rewards. These studies have been performed for an access to feed, a conspecific, a different environment and many other cases. They are divided in two main categories: the choice tests, and operant tests (Kirkden & Pajor 2006). The choice tests consist in a series of alternative choices of environment or resources. They lead to a certain number of possible combinations as results. The operant tests consist in the access to one resource or environment. It leads to a binary situation: either animals have a positive response to the test or not (Kirkden & Pajor 2006 and Bigelow & Houpt 1988). More, the cost for accessing the rewards can also be part of the experiment settings (Kagel et al. 1995). Then, some economic theories can be tested on the animals, such as the slope of demand curve or the price elasticity of demand (Kagel et al. 1995). That can be evaluated with increasing or decreasing efforts to gain access, at fixed or interval ratios.

1.3 Links between health, feeding, and behaviour of piglets

Feeding and digestive health

Creep-feed consumption improves the digestive system development and the weight gain of piglets (Pajor et al. 1991). Also, the creep-feed consumption may be impacted by the piglet's birthweight (Pajor et al. 1991). In case of insufficient feeding space, more active and bigger piglets tend to push out quiet and smaller ones from the feeder at feeding time (Pajor et al. 1991). This makes a hierarchy at the feeder. Then, for countering such unwilled phenomena it is advised to have feeding space enough (Pajor et al. 1991). It increases the amount of creep-feed consumed per piglet. More, piglets with a good creep-feed intake show a smoother feed transition during the period after weaning, thanks to a better preparation (Pajor et al. 1991). Besides, eating more creep-feed can partly replace insufficient milk intake for piglets (Pajor et al. 1991). Piglets having milk replacer beside suckling sow during lactation have longer intestinal villi and are heavier after weaning (Solà-Oriol & Gasa. 2017). This leads to a better and more mature intestinal health, preferable for a smoother weaning transition.
Also, the quantity of ingested feed has effects on the intestinal health (Middelkoop 2020). Assuring a certain level of feed ingestion helps to improve the weaning transition for piglets (Bruininx et al. 2002).

Feeding and behaviour

Having a dietary diversity with several different feeds stimulates more feed intake and exploration than just having a same feed with different flavours (Middelkoop et al. 2018). However, it doesn't improve the piglet percentage consuming feed, neither their early growth before weaning (Bruininx et al. 2004; Pluske et al. 2007). But it has a positive impact on their growth after weaning.

Digestive health and behaviour

Homer et al. (2023) reports studies linking intestinal microbiota and behavioural disorders in several species, including pigs. This literature review enlightens the impact of unbalanced gut-microbiotas on pigs' behaviour. For example, tail biting (as aggressor and victim), fearful behaviour and lack of exploratory behaviour relate to microbiota disorders (Homer et al., 2023). The intestinal microbiota starts its development from the first hours of piglets after birth (Choudhury et al., 2021). It can be altered because of piglet's environment and feeding. Maintaining a good microbial population is important for being sure final degraded products and nutrients are absorbed in the digestive system (Choudhury et al., 2021). A proper diverse feed diet is factor of a healthy gut microbiota (Choudhury et al. 2021).

1.4 Legislation

The legislation of the European union states that materials such as peat, straw, hay and others must be provided for piglets (European Council 2019). The aim is to stimulate the natural exploratory behaviour and avoiding damaging behaviours (van de Weerd & Ison 2019 ; European Council 2019). Moreover, Sweden set some goals about sustainability and agriculture in its 2030 agenda (Nilsson 2017). It evocates a more competitive, innovative, attractive and sustainable food chain sector. This aims to enhance national growth, employment, and fostering sustainable development. As previously quoted, modern pig farming and legislation don't rely enough on feed diversity and foraging for enhancing animal welfare (Godyń et al. 2019; Young et al. 1994). This is a point research and legislation still have to work on.

Sustainability

SLU's motto being 'Science and education for sustainable life', this research must approach sustainability (SLU 2025). The sustainable development has seventeen goals divided in three pillars: environmental, economic and social (United Nations 2015). This experiment is performed in the frame of an experimental program titled: '*Freedom of choice: using natural foraging behaviour to promote health and welfare in commercial pig production'*. Indeed, the program promoting health and welfare in pig production integrates well in sustainable development. The promotion of animal health fits in the economic and environmental pillars. By promoting a farming healthier for pigs we can reduce the animal medicine purchases, releasing fewer polluting molecules in the environment and minimizing expenses in veterinarian medicines. Then, animal welfare also has a place in the environmental pillar by respecting the life on land (Goal 15 from United Nations 2015). It also has a place in the social pilar, people paying importance to the ethic of their consumptions (United Nations 2015). People consumption reaching their ethical standards is part of human well-being.

1.5 Knowledge gap

There is a knowledge gap concerning the effects of feed choice combined to foraging on piglets' health, damaging behaviour, incidence of diarrhoea and growth during lactation and early post-weaning. The generated knowledge will provide information in the aim to promote foraging of several diverse feed in commercial pig farming if results show interests.

Solution to be implemented

For fulfilling this knowledge gap, behavioural applied research must be performed. This research will give further knowledge about piglets' behaviour and is in the line of the Swedish 2030 Agenda for a more sustainable food chain sector (Regeringskansliet 2017).

Aim

This research aims to compare the effect of freedom of choice on health, weight gain, damaging behaviours (e.g., ear and tail biting) and the incidence of diarrhoea during the periods before and after weaning.

Hypothesis

In accordance with the referred literature and the aim of this research, the hypothesis formulated is the following one:

The freedom of choice will promote growth and health during the weaning period, while also reducing damaging behaviours.

2 Materials and methods

This scientific experiment has been conducted at the experimental pig farm of the Swedish University of Agricultural sciences at Funbo Lövsta, in Sweden. The data collection took place from September 16th, 2024, to March 19th, 2025, over three sow batches. This experiment got an approved animal ethics application from Jordbruks verket before starting (Order n° 126748).

2.1 The three different treatments of the experimentation

This study compares three treatments on piglets from one to seven weeks of age, with a weaning at 5 weeks old (± 3 days). The treatments are called 'free-choice', 'no-choice', and 'control' treatments. The free-choice treatment consists in exposing piglets to five different feeds in five different playful feeders in an additional pen. These feeds and feeders are indicated in *Appendix 1*. For going out of their pen, they must push a weighed door. That weight increased over the experimental phase. They were exposed to that treatment twice a week. The no-choice group had the same weighed door but instead of having access to five feeds in five playful feeders, piglets only had their usual creep feed in the same kind of feeder as they had in their main pen. The control group was raised under conventional Swedish farming conditions and didn't follow any particular treatment.

2.2 Housing

At SLU's experimental farm of Funbo Lövsta, the seven farrowing units are made of twelve pens, each one for a sow and its litter. In each unit, there are two lines of six pens, and three corridors: on each side of the room, and one in between the two pen lines.

The experimental setting

During the experiment, a maximum of ten pens were used in the rooms. Then, there were two pens available for applying the free-choice and no-choice treatments. Each empty pen had to be in between two occupied pens, and each occupied pen had to be near an empty one (*Figure 1*). Each free-choice and no-choice pen had a specially crafted door, having two piglet gates: one way-in and one way-out (*Figure 2*). The gate way-out the pen had adjustable door stoppers for weighing that piglet' door. Then, during the experimental sessions, the side corridors of the room were closed to allow the piglets to only enter the pen with rewards.

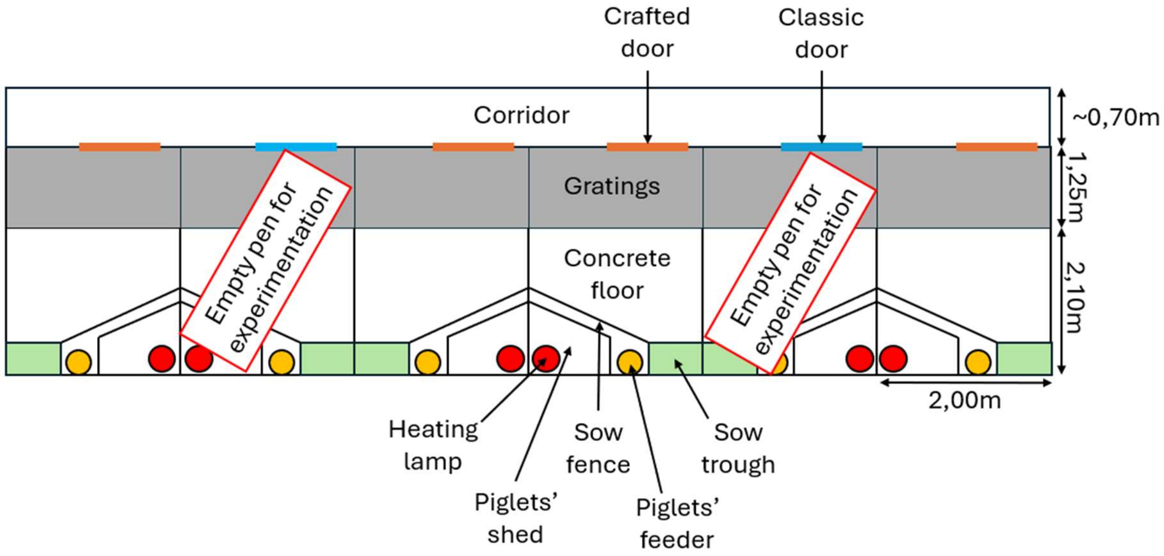

Figure 1: Plan of the experimental setting (half of a farrowing unit) (personal creation)

Figure 2: Picure of a no-choice litter after-weaning during an experimental session (personal picture)

On the picture: Piglets' main pen on the left, with the crafted door. The way-out gate being on the middle of the door, and the way-in gate on the left. In background, the corridor is obstructed on the left of the piglets' gate, and right after the extra-pen entrance. The extra-pen is on the right and only contains a usual feeder (yellow pipe) with ad-libitum feed. This is a no-choice treatment litter. The choice treatment litters had five playful feeders in the extra pen. The control groups have spent all the experiment time in a pen alike the main one.

2.3 Animals

Three sow batches were included in this study. Each batch was composed of 6 sows and their litter, but the first one was made of three sows. For the second and third batches, two sows and litters were attributed to each treatment. The first batch was made of one sow and litter per treatment. Litters' treatment was defined on the morning of the first day of a training week for piglets. They were attributed on our team appreciation, depending on the animals' availability and animals' behaviour after sows' selection. Among the litters available, the easiest to handle and healthiest litters were chosen for the choice and no-choice treatments. The control treatment litters had to be healthy, but it happened to select sows less easy to handle in case of litter shortages. After that first selection a training week started for the free-choice and no-choice piglets.

Piglets

From birth to weaning, litters and sows were kept in a loose-housed farrowing pen, with a piglet's corner, protected from the sow by a fence. Then, five weeks after farrowing (± 3 days) sows were removed from the pen. Piglets stayed in their pen till their ninth week of age. Hence, they were in the same pen all over the experimental phase from the end of their first week till seven weeks of age. Concerning cares, piglets had an ear tag and iron injection five days after birth. They also had a second iron injection two weeks later. Pigs were raised under Swedish conventional conditions. Piglets went through chemical castration for male piglets, but no tail docking, neither canine teeth grinding. During lactation and till the end of the experimental phase of piglets, chopped straw was daily distributed to animals. Every Monday afternoon of the experimental phase, piglets went through painting of their experimental number on their back, then weighing, and a visual health check with assessments. The list of performed assessments is presented in *Appendix 2*. Totally, 15 litters including 153 piglets - 85 males and 68 females - have been included in this experiment. Piglets were crossbred based on Z lines and Yorkshire by their sow, and Hampshire from the boar.

Training week

The week of training started when piglets were one week old, on Monday morning. It was right after attributing treatments to litters. During this week, all piglets from no-choice and free-choice groups were highly stimulated for going out their pen, accessing the extra pen. For this, the piglets' door was kept open and rewards like grape, yoghurt, raisins and popcorn were disposed in the extra pen. They had access to such facilities for one or two 20 minutes sessions per day for five consecutive days. The two firsts' days, the door was kept open. The third day, the door was half-way closed, kept by a 10kg weight. The fourth day, the door was 'quarter way open' with the same weight. On the fifth day, the door was kept closed with the lightest weight possible. The aim being to teach piglets to push the little door for accessing rewards and toys in the extra-pen.

Piglet selection

Following this training week, we performed piglets' selections for the actual experiment. For the free choice and the no-choice litters, the ten piglets the most performant at passing the door were selected and marked with an experimental number from one to ten (sometimes up to twelve for balancing effectives among groups and batches). The experimental numbers were written with human hair dye. The other piglets remained with the litter without being weighed, health checked or taken in account in the behavioural experiment. For the control group, piglets were randomly selected but for one litter, which the ten best looking piglets were selected for behavioural observations. It happened because of a shortage of litter availability in that batch. After this training week, the actual experiment started.

Sows

Fifteen sows were involved in this experiment, over three batches. All were crossbred on the base of Z-line and Yorkshire. For being selected, they preferably had to be second parity, healthy, having ten healthy piglets or more, and being easy to handle. One first parity gilt was selected because of a sow shortage (*Table 1*). They came in the farrowing units a week before their farrowing expectation. They were weighted and had body-condition assessment before coming in the farrowing unit. All over lactation, sows were fed with dry feed. They got fed twice a day till the 10th day of lactation, then three times a day.

Table 1: Litters included in the experiment

Batch	Treatment group	Sow number	Parity
1	choice	42850	2
1	no-choice	39099	5
1	control	41402	3
2	control	39550	5
2	control	43261	2
2	choice	38194	6
2	choice	39098	5
2	no-choice	40822	4
2	no-choice	43260	2
3	control	39100	6
3	choice	45434	1
3	no-choice	44334	2
3	control	44335	2
3	choice	33463	9
3	no-choice	38853	6

2.4 Study design

The experimental sessions

For the free-choice and no-choice groups, piglets had access to the extra-pen 20 times for 2 minutes consecutively twice a week. Piglets from the no-choice group had access to an extra-pen with creep-feed in a usual feeder as reward. The free-choice group had access to 5 different feeds in 5 different playful feeders. Feeds and toy-feeders were randomly alternated every session day for stimulating piglets foraging and exploratory behaviour. The list of playful feeder and feed combinations used is in *Appendix 1*. In between every 2 minutes sessions piglets were driven back to their own pen and feeders were refilled. The next session started as soon as feeders were refilled. These experimental sessions occurred between nine and eleven in the morning. The control groups never had access to extra feed in an extra pen.

The weighted doors were progressively set heavier and heavier for measuring piglets' willingness to ´pay´ for accessing extra-feed, experimental session day after experimental session day. In behavioural economic terms, it was a fixed ratio for piglets. On the first experiment day it was set on 0,7kg weight, and 13,5kg on the last experimental session of piglets. Each new experimental session, the door weight settings increased according to setting presented in *Table 2*.

Table 2: Schedule of weight strength set on the piglets' gates

Weeks of experiment	Weight strength set on the door gate
1st week	Training week settings
2nd week	0,7 kg 1,0 kg
3rd week	2,0 kg 3,5 kg
4th week	6,9 kg
Weaning	
5th week	2,7 kg 4,2 kg
6th week	8,5 kg 13,5 kg

Scored and occurrence data

The scored data included faeces consistency and colour, manure on the piglet, tear stains, sores on knee. The occurrence assessments included 'tail lesions' and 'other issues'.

The health checks:

Piglets were health checked once a week, from the 7th to the 49th day of piglets (± 3 days), on Monday afternoons. Their assessment is performed by filling up the document in *Appendix 2*. Only the left side of animals was assessed for having standard measures, as preconised in Welfare Quality Network (2009). Observations were made every week from observation one to seven, but weighing were only made on the day of birth, and from the fourth health check. Observations and weighing were always made right after repainting the experimental number of piglets on their back. The last observation was made after the last experimental session of the sixth week of experiment. Assessments have been performed by several people over the experiment. Each of them had training and explanations for assessing the same way.

Observations

The observations taken as data are:

- The birth weight, the weaning weight, and the weight at the seventh observation, for comparing weights and average daily gains over group experiments.
- Scored assessments, inspired from Welfare Quality Network (2009):
    - 'Faeces' consistency, colour. 'Faeces' was graded from 0 – usual appearance – 1- Appearance lightly different – to 2 – serious unusual appearance. In this case, it mainly concerned piglet scouring. That was assessed per individual.
    - 'Manure on' the piglet. 'Manure on' was graded from 0 to 2 grading the amount of manure stains on piglets. "0" being no manure on the body, "1" up to 10 percent of the body covered by manure, and "2" being more than 10 percent.
    - 'Tear stain' was assessed from 0 to 2 as well, one being a tiny stain, and 2 a real drip, covering 50% or more of the eye area (Telkänranta et al. 2016).

    - ‘Sores on knee’ was also assessed from 0 to 2. 1 being a simple crust and 2 a serious bleeding sore.
- Occurrence assessments:
    - ‘Tail’ lesions and ‘other’ (any other issues) were assessed as 0 or 1. 0 being no problem, and 1 any problem(s). For tail issues occurrence, it concerned bitemarks, skin lesions, and any other issues.
- Counted assessments
    - ‘Skin lesions on the front’ counted skin lesions from the snout to the rear of the shoulder, excluding the ear and leg.
    - ‘Skin lesions on the middle’ counted skin lesions from the should rear to the fore part of the ham.
    - ‘Skin lesions on the rear’ counted the skin lesions on the ham to the interstice in between hams excluding the leg and tail.
    - ‘Skin lesions on the ear’ counted skin lesions on the left ear.
    - ‘Skin lesions on the legs’ counted skin lesions on the leg.

These observations were performed in the aim to evaluate piglets’ health, weight gains, damaging behaviours and the incidence of diarrhoea.

2.5 Data analysis

Data were collected on paper at farm and copied online on shared Microsoft Excel (2016) files by hand on a daily base. From these online documents, data files were made up for being processable on CRAN Rstudio 4.4.2 (2024) for further statistics and data processing.

2.6 Statistics

All statistics and plots have been made with CRAN Rstudio 4.4.2 (2024). The aim being to evaluate the impact of treatments on early post-weaning, data got split in two parts: before weaning (or pre-weaning) and after weaning (also named post-weaning). Before weaning considers the observations 1 to 4 and after-weaning the observations 5 to 7.

Scored and occurrence data

These two categories of assessments mainly went through chi square tests for statistic analysis. Only ‘other’ (any other issues), had a Fisher-Pearson test after weaning because of some data having too few concerned individuals for a Chi square test. Then, significant data went through post-hoc tests, for furthering the results. All the post-hoc tests performed on significant scored assessments were Bonferroni correction tests. In reason of the three groups presented in this study, the corrected Bonferroni p-value for statistical significance is:

Corrected Bonferroni p-value = $\frac{\text{P−val}}{\text{3 groups}} = \frac{0{,}05}{3} = 0{,}0167$

The scored data have shown very few cases of severe issues, scored ‘2’. Therefore, for statistical and reliabilities reasons, all these data were considered as two categories in tests: either 0 or 1-2. This makes it more of an occurrence test than an assessment.

Counted data

The chi square test was performed on skin lesions. The ones having more than 20% of data ranges with less than 5 observations in effectives went through a Fisher-Pearson test. They were middle and rear skin lesions before weaning, the ear skin lesions after weaning, ear and middle skin lesions from birth to seven weeks old. The post-hoc analysis performed were Bonferroni corrections for the chi-square significant tests, and Fisher-Bonferroni corrections for the Fisher-Pearson tests. For the same reason as scored data, the corrected Bonferroni p-value is 0,0167 for statistical significance.

Weights and ADG

Only the Birth, Weaning and Observation 7 weights (from the last health check) were considered. The average daily gain has been calculated by the following formula with Microsoft Excel (2016):

$$\text{ADG from birth to weaning} = \frac{\text{Weaning weight (kg)} - \text{Birt} \quad \text{weight (kg)}}{Weaning\ date - Birth\ date}$$

$$\text{ADG from weaning to observation 7} = \frac{\text{Observation 7 weight (kg)} - \text{Weaning weight (kg)}}{Observation\ 7\ date - Weaning\ date}$$

Because of the non-parametric repartition of some weights in some groups, a Kruskal-Wallis's test has been performed. The post-hoc analysis following was a Dunn test, comparing each group among the three weighing.

3 Results

3.1 Health

Sores on knee

Sores on knee shows a tendency for different results among groups in *Table 3* after weaning. The no-choice group shows the highest mean percentage of piglets with knee sores per observation over the period before-weaning, with the smallest standard error. It is followed by the choice group (*Figure 3*). The sores on knee post-hoc Bonferroni corrections don't show a difference between the choice and control group from birth to seven weeks old (p value > 0,0167). From *Figure 3*, sores on knee are an issue that tends to be less common after weaning. However, the control group has the lowest rates before and after weaning.

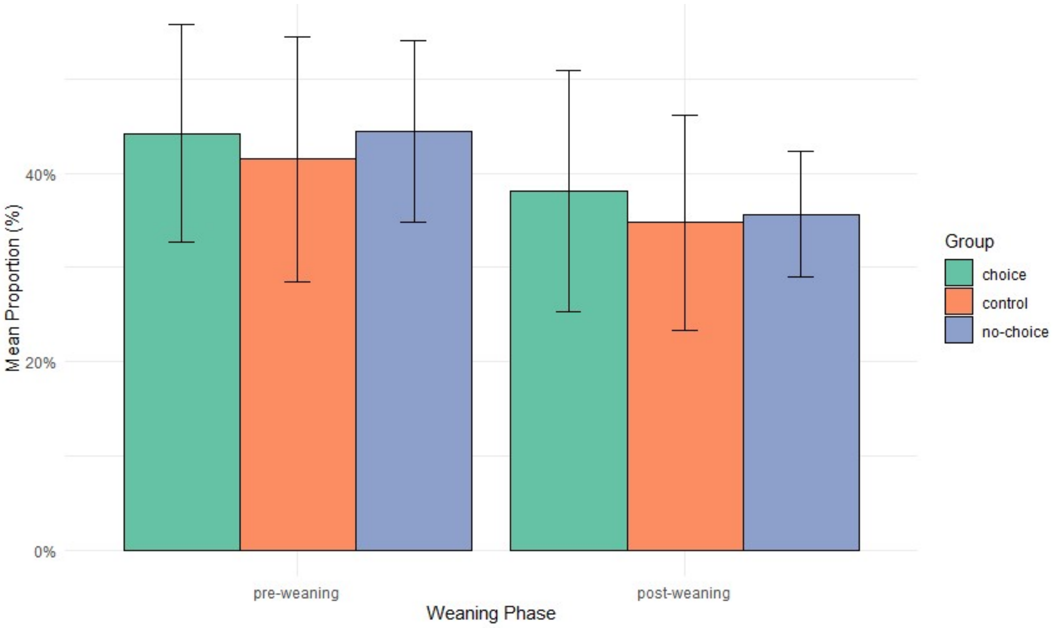

Figure 3: Mean percentages and standard errors of knee sores per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Other problems

Other problems have shown the highest mean percentage of occurrence for the no-choice group followed by the choice group over the period before weaning (*Figure 4*). However, the significance of these numbers isn't confirmed. Only a tendency has been found for the before weaning and from birth till seventh weeks old periods (*Table 3*). *Figure 4* shows a decreasing for all groups before and after weaning. However, the choice group shows the lowest mean percentage after weaning, and the main decrease as well: It has the second place before-weaning, and the lowest one after. Moreover, the standard error after weaning shows no value. In overall, the other issues were mainly made of 19 cases of snout lesions observations, and 15 skin diseases observations.

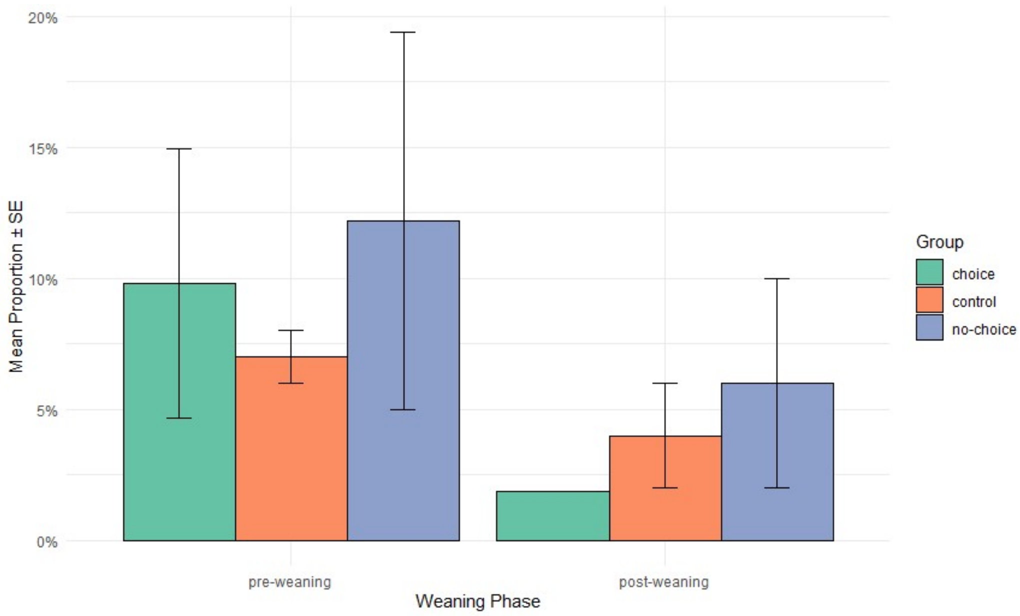

Figure 4: Mean percentages and standard errors of other issues per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Table 3: Health statistics of piglet groups per period.

Periods	Assessments	test	X^2 (alternative hypothesis for fisher test)	df	p-value
Before weaning	other	chi-square	5.1759	2	0.07517
	sores on knee	chi-square	3.8666	2	0.1447
	tear stain	chi-square	2.1368	2	0.3436
After weaning	other	fisher-pearson	two.sided	/	0.5306
	sores on knee	chi-square	5.8656	2	0.05325
	tear stain	chi-square	0.077164	2	0.9622
From birth to seven weeks old	other	chi-square	5.1682	2	0.07546
	sores on knee	chi-square	8.2947	2	0.01581
	tear stain	chi-square	1.2678	2	0.5305

3.2 Weight gains

Weights

The group weights enlighten several things. The birth weights don't show any significative differences among groups (*Table 4*). Concerning weaning weights, the control group has the highest weight compared to the no-choice, and control groups (*Table 5, Figure 5*). The no-choice group is second heaviest group. However, this last group also has the biggest standards error among the three. The seventh observation from the same chart shows the same plot order, as a difference that only the choice and control group show significant different weights according to a Kruskal-Wallis test (*Table 5*). The choice group having a significant lower weight than the control group and the no-choice group tending to have lower weights compared to the control group at weaning observation 7 (*Table 5*).These statistics indicates a choice group with non- significant different weight at birth, then getting significantly lighter than other groups with age. Concerning the weight at the seventh observation, the control group shows heavier weights than the choice group. However the no-choice group doesn't show significance with the choice and control groups (*Table 5*).

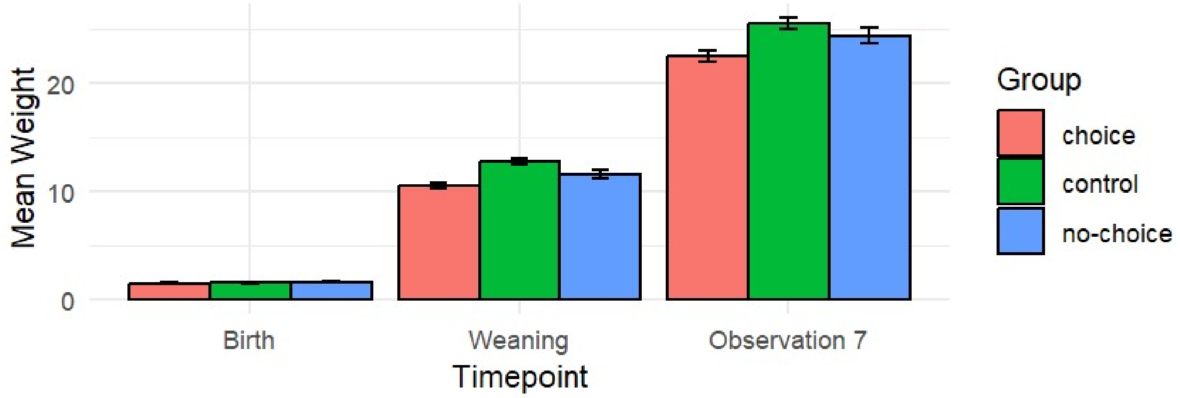

Figure 5: Mean weights and standard errors of piglets per group and timepoint (choice group n = 53; no-choice group n = 50; control group n = 50)

Table 4: Kruskal-Wallis statistic tests of weights of piglet groups per weighing.

Timepoint	n	Statistic	df	p
Birth	123	3.88	2	0.144
Weaning (5 w.old)	123	26.1	2	0.00000218
Observation 7 (7 w.old)	123	14.5	2	0.000711

Table 5: Dunn post-hoc statistic tests of weights of piglet groups per weighing.

Scaling	Group1	Group2	n1	n2	statistic	p	p.adj
Birth	choice	control	43	40	0.475	0.635	1
	choice	no-choice	43	40	1.90	0.0569	0.171
	control	no-choice	40	40	1.40	0.160	0.481
Weaning	choice	control	43	40	5.10	0.000000339	0.00000102
(5 w.old)	choice	no-choice	43	40	2.67	0.00762	0.0229
	control	no-choice	40	40	-2.39	0.0169	0.0507
Observation 7	choice	control	43	40	3.81	0.000141	0.000423
(7 w.old)	choice	no-choice	43	40	1.92	0.0549	0.165
	control	no-choice	40	40	-1.85	0.0638	0.191

Average daily gain

The average daily gain shows no significant difference before weaning, among groups (*Table 6*). However, even though groups have significantly different ADG after weaning, when comparing groups against each other in a post-hoc Kruskal-Wallis test, none of the comparisons showed significance. Also, *Figure 6* shows areas of standard errors very similar for the three groups during the after-weaning period.

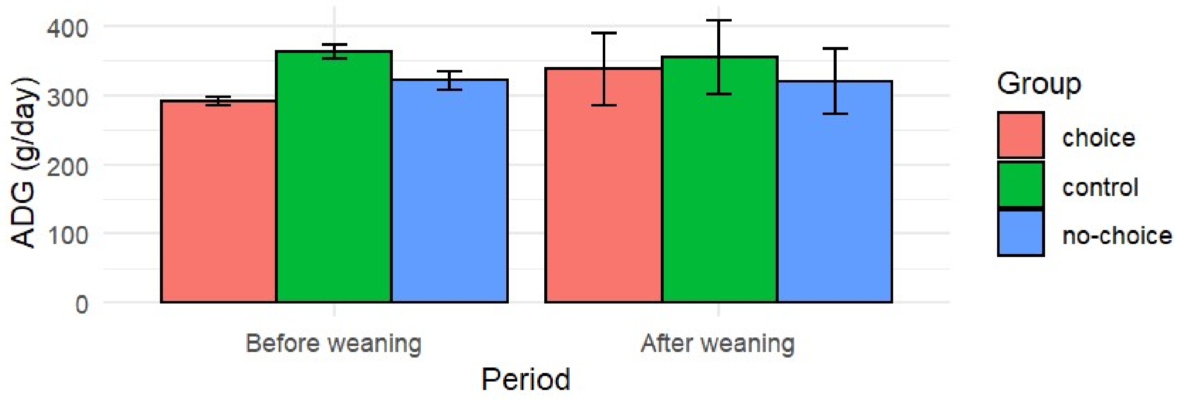

Figure 6: Mean ADG and standard errors before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Table 6: Kruskal-Wallis statistic tests of piglet groups average daily gain before and after weaning.

Period	n	Statistic	df	p
Before-weaning	123	1.82	2	0.403
After-weaning	123	27.1	2	0.00000127

3.3 Damaging behaviours

Tail issues

Concerning the observations before weaning, the tail issues have shown significant results. *Figure 7* indicates the no-choice group having the biggest percentage of tail issues per weekly observation per group in average, while the control group shows the less before weaning. However, the standard error of the no-choice group is the biggest of all three, showing the biggest disparity in results than other groups during that time range. The mean percentage of piglets having tail issues per observation are about six percent for the choice group, three and a half for the control group and twelve for the no-choice group. The post-hoc test results show the only significant comparison is choice and no-choice group ($p<=0.0167$) during the period before weaning (*Table 7*). That is statistically significant and significant for the Bonferroni corrections. It means these two groups have more significant difference than choice group and control group. In a nutshell, everything indicates the no-choice group has significantly the highest mean count of tail issue occurrence per observation, followed by the choice group. The post-hoc test for tail issues from birth to seven weeks old has been performed. But none of the results' figures show significancy. Also, *Figure 7* makes a rise appearing from before to after weaning, for all groups.

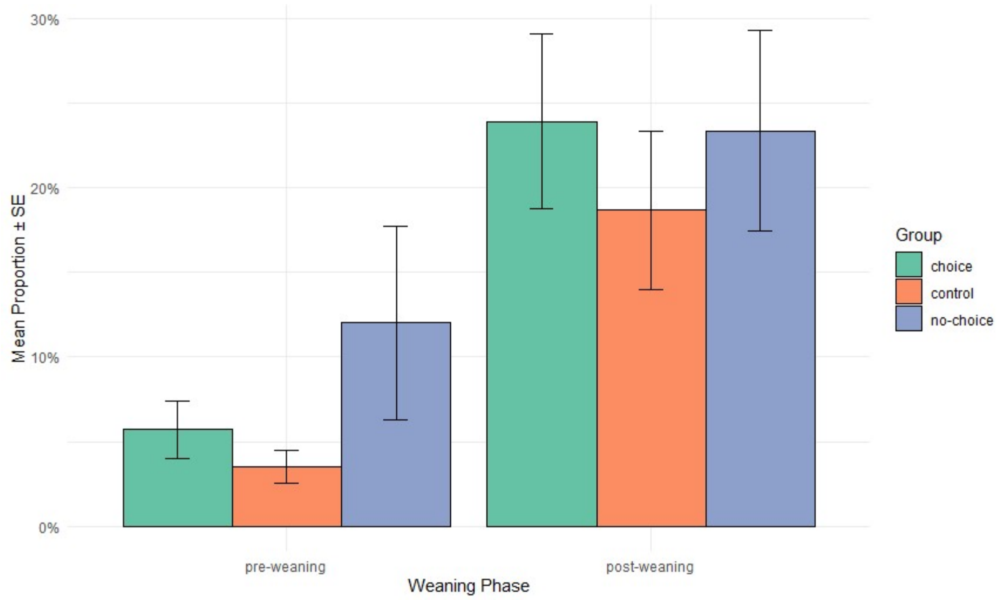

Figure 7: Mean percentages and standard errors of tail issues per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Table 7: Damaging behaviours - scored assessments' statistics of piglet groups per period.

Periods	**Scored assessments**	**test**	**X^2 (alternative hypothesis for fisher test)**	**df**	**p-value**
Before weaning	tail	chi-square	11.98	2	0.002504
After weaning	tail	chi-square	1.4607	2	0.4817
From birth to seven weeks old	tail	chi-square	7.1418	2	0.02813

Skin-lesions

Ear skin lesions

Figure 8 shows the choice group having the biggest mean percentages of piglet with none and one to three skin lesions. The no-choice group has more piglets without skin lesions in average than the control group, and a bit less piglets with one to three lesions. That observable phenomenon enlightens that choice treatment shows more piglets with fewer skin lesions, followed by the no-choice treatment. The results shown in *Table 8* indicate the ear skin lesions having significant results before, after weaning, and from birth to seven weeks old. Post hoc statistics show the choice group having significative figures for Bonferroni correction with piglets having from four to six lesions before weaning and from birth to seven weeks old (p<= 0,0167).

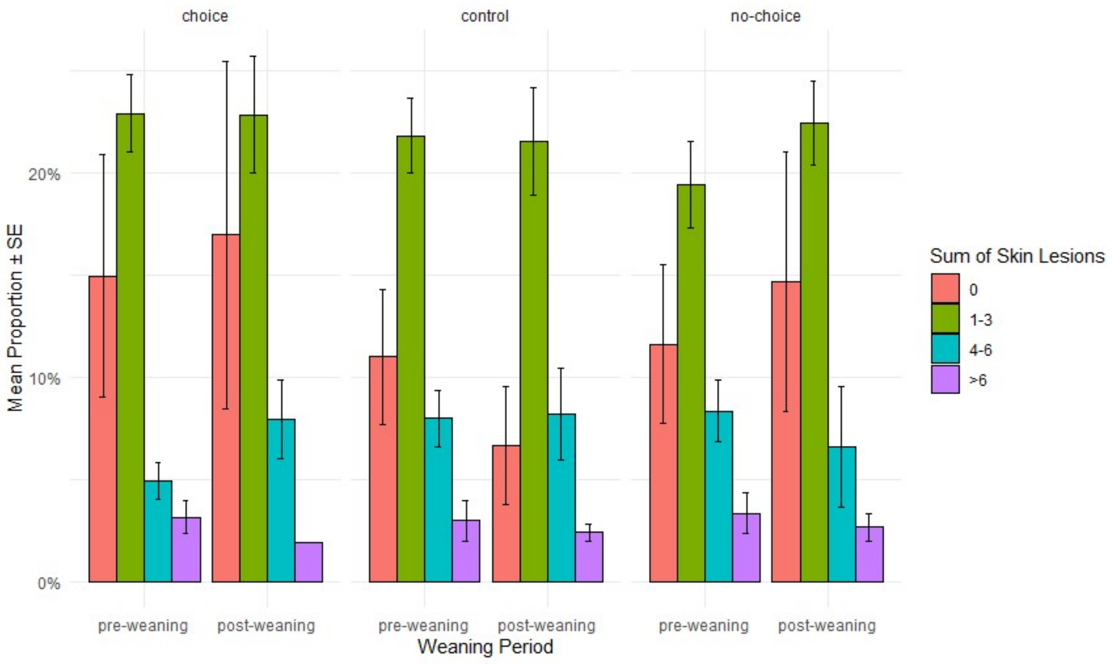

Figure 8: Mean percentages and standard errors of ear skin lesions count categories per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Front skin lesions

Figure 9 indicates the no-choice group having the biggest mean percentage of piglets without skin lesions before weaning, followed by the choice group. During the same time range, it also has the fewest piglets with one to three, and four to six lesions. After weaning, the control group shows the lowest mean percentages of piglets having no skin lesions, and one to three skin lesions. The no choice group has the highest mean percentage of piglets without skin lesions once again, followed by the choice group. Therefore, that plot indicated the no-choice group having the highest mean percentage of piglets without skin lesions. The choice group has the more piglets with one to three lesions. After weaning, the control group shows significance for piglets with more than six lesions, and zero lesions from the post-hoc Bonferroni corrections (p=0,0167). The no-choice group is also significant for the Bonferroni correction concerning the zero lesions' piglets. Concerning the post-hoc statistics from birth to seven weeks old, the control and no-choice group have shown significant differences with the choice group (p=0,0167) for piglets without front skin lesions. The control group has shown statistic difference with the choice group (p=0,0167) for piglets having from four t six lesions. Then, for piglets over six skin lesions, the Bonferroni corrections the choice group has significantly less piglets than other group (p=0,0167). Overall, these results indicate the no-choice group being the one with the highest mean count of piglets with fewer skin lesions in any case, and with the most significant cases. Oppositely, the control group shows the biggest means counts of piglets with more than six lesions, and the fewest mean count of piglets with zero lesions, significantly.

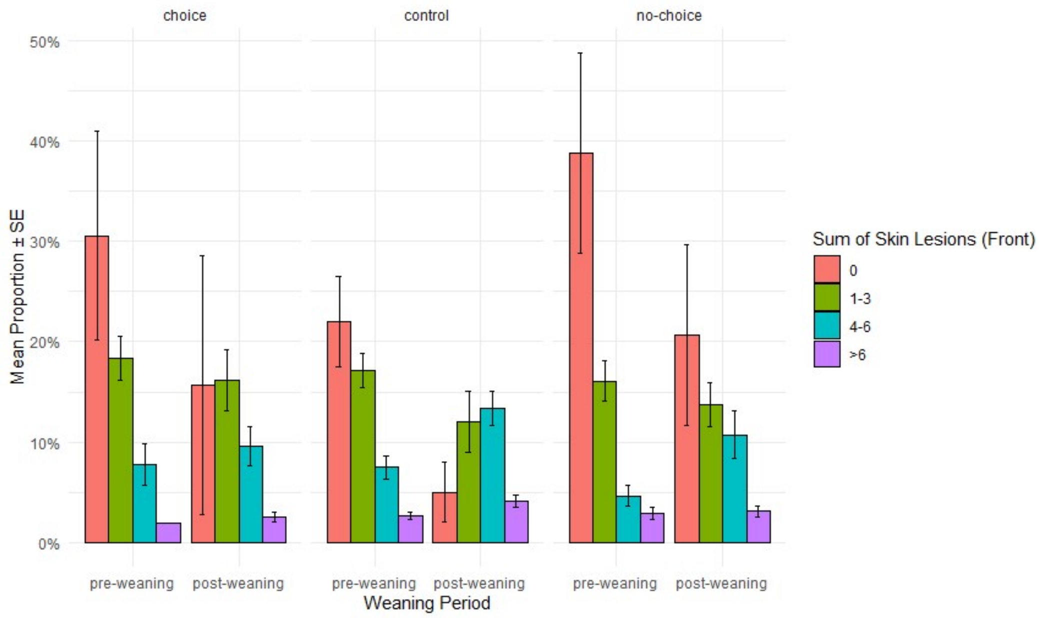

Figure 9: Mean percentages and standard errors of front skin lesions count categories per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Middle skin lesions

In *Figure 10*, the mean percentages of piglets without middle skin lesions before weaning are equally highly represented in the choice and the no-choice groups. Over the same time lap, the control group show the highest mean of piglets having four to six and more than six lesions per observation. But the control group has the most piglets with one to three lesions, followed by the choice group. From a statistical point of view, the middle skin lesions are significant before, after weaning and all over the experimental phase (*Table 8*). It shows significance in post-hoc analysis with Fisher-Bonferroni corrections. There is significance before weaning in choice vs control groups. After weaning, only the control group shows significant result. They are significant from Bonferroni corrections for piglets having more than six lesions, and zero lesions. From birth to weaning, the choice compared to no-choice group have a good significance with Bonferroni corrections (p= 0,0167). However, the plots results show the control group having the fewest piglets without skin lesions before weaning. After weaning, the control group follows the same pattern and even have the biggest mean percentage of piglets having between 4 and 6 and more than 6 lesions.

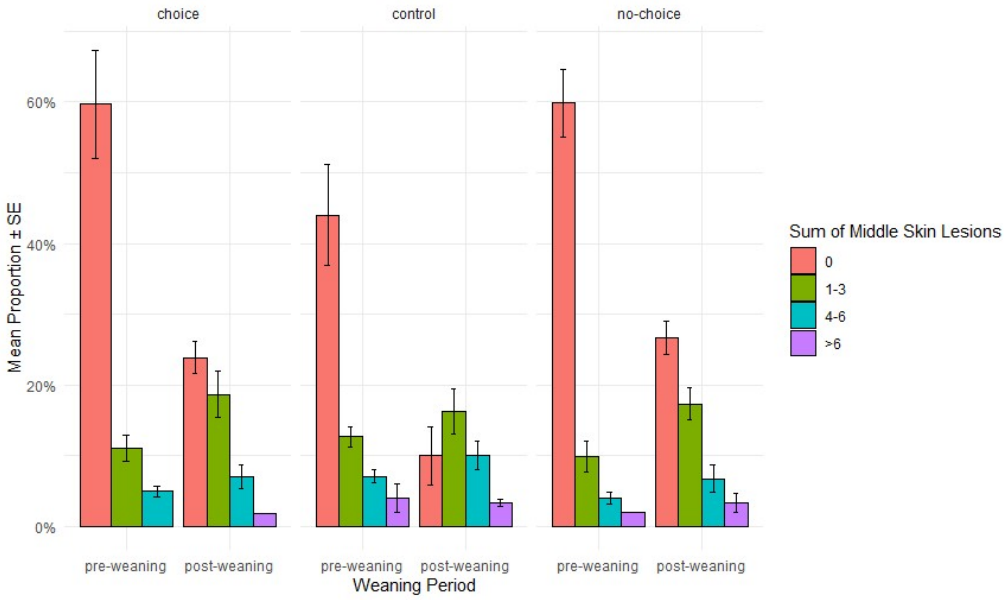

Figure 80: Mean percentages and standard errors of middle skin lesions count categories per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Rear skin lesions

Rear skin lesions were the less common of the significant skin lesions during the experiment, categorized as one to three, and more than three. The choice group show the highest mean percentage of piglets without lesions before and after weaning, followed by the no-choice treatment (*Figure 11*). However, the no-choice group has the smallest means of piglets having from one to three skin lesions (*Figure 11*). The rear skin lesions have shown significance all over the experiment, and before weaning (*Table 8*). From post-hoc statistics, the comparison between choice and control groups before weaning is significant for the Bonferroni corrections. From birth to seven weeks old, only the choice group with piglet having more than three lesions is significant for the Bonferroni corrections.

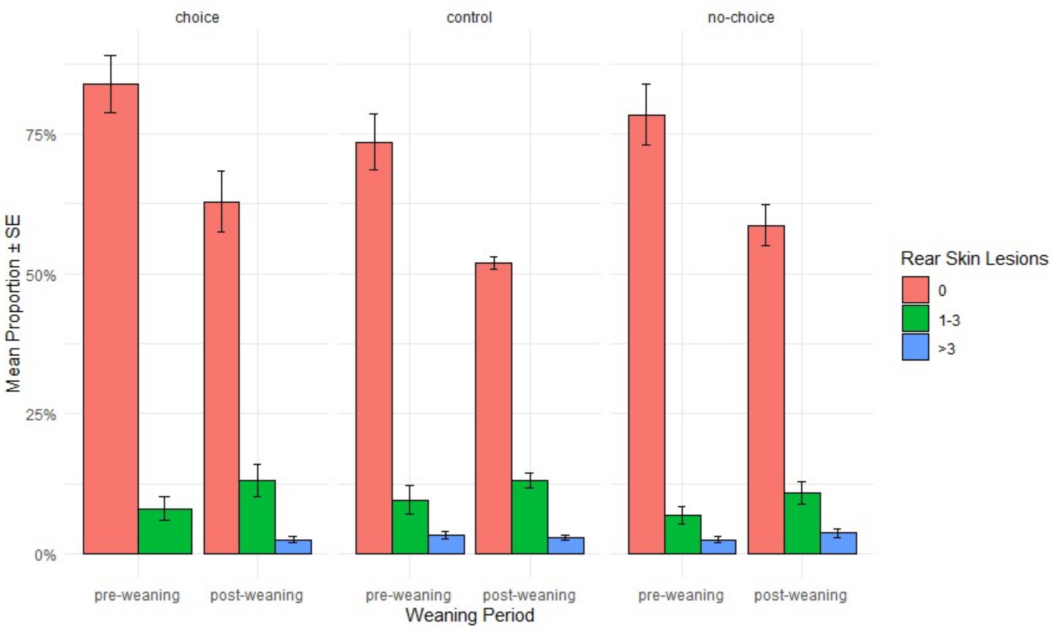

Figure 91: Mean percentages and standard errors of rear skin lesions count categories per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Table 8: Damaging behaviours - Skin lesions' statistics of piglet groups per period.

Periods	Skin-lesions assessments	test	X^2 (alternative hypothesis for fisher test)	df	p-value
Before weaning	Ear	chi-square	16.063	6	0.01342
	Front	chi-square	25.722	6	0.0002508
	Legs	chi-square	1.2222	2	0.5427
	Middle	fisher-pearson	two.sided	/	0.001999
	Rear	fisher-pearson	two.sided	/	0.0243
After weaning	Ear	fisher-pearson	two.sided	/	0.01179
	Front	chi-square	38.263	6	9.98E-07
	Legs	chi-square	4.4927	2	0.1058
	Middle	chi-square	30.596	6	3.03E-05
	Rear	chi-square	8.6124	4	0.07155
From birth to seven weeks old	Ear	fisher-pearson (10000 replicates)	two.sided	/	0.0016
	Front	chi-square	47.236	NA	1.00E-04
	Legs	chi-square	1.1524	2	0.562
	Middle	fisher-pearson	two.sided	/	1.00E-04
	Rear	chi-square	16.681	4	0.002229

3.4 Incidence of diarrhoea

Faeces issues

The faeces issues before weaning show a tendency of occurrence ($0.05 <= p < 0.1$) (*Table 9*). Results show a mean percentage over 6% for the choice group, about 7% for the control group, and a mean of 4% for the no-choice group (*figure 12*).

Considering the significance and the results shown in *figure 12*, the control group seems having the highest significant mean count of faeces issues occurrences over the experiment. In f*igure 12*, the occurrence of faeces issues increases for all group from before to after weaning. Then, the order remains the same in both phases, the control group having the most piglets with faeces issues per observation, followed by the choice group.

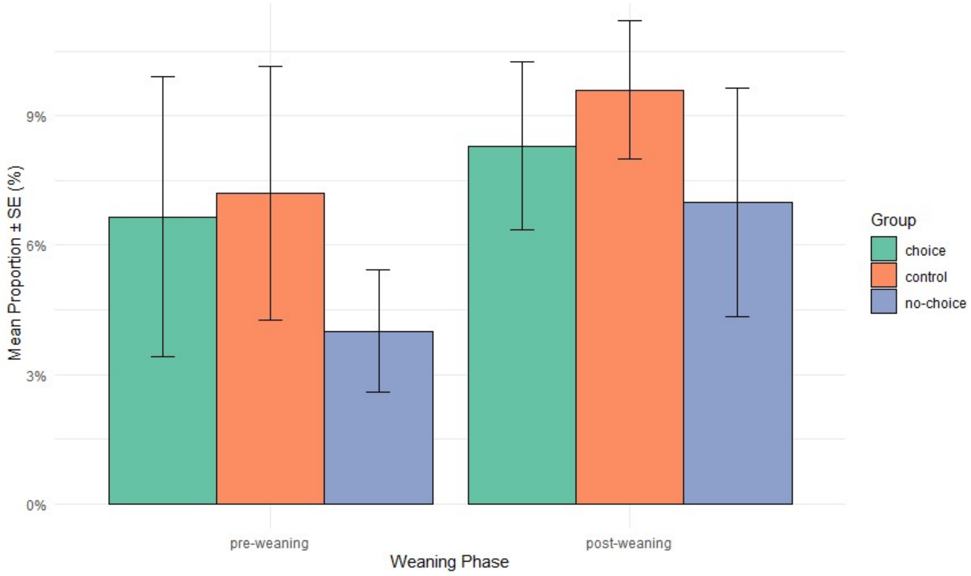

Figure 12: Mean percentages and standard errors of faeces issues per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Manure on piglets

In *Table 9*, Manure on results shows statistical tendency after weaning (p=0,05). The highest mean of piglets with manure-on issues is owned by the control group, followed by the no-choice group with a bigger standard error (*Figure 13*).

All the groups have their mean percentage of manure on piglets increasing from before to after weaning. But their evolution differs. The choice group is the highest one before weaning, followed by the control group. After-weaning, the choice group has the lowest mean percentage, and the control group has the highest.

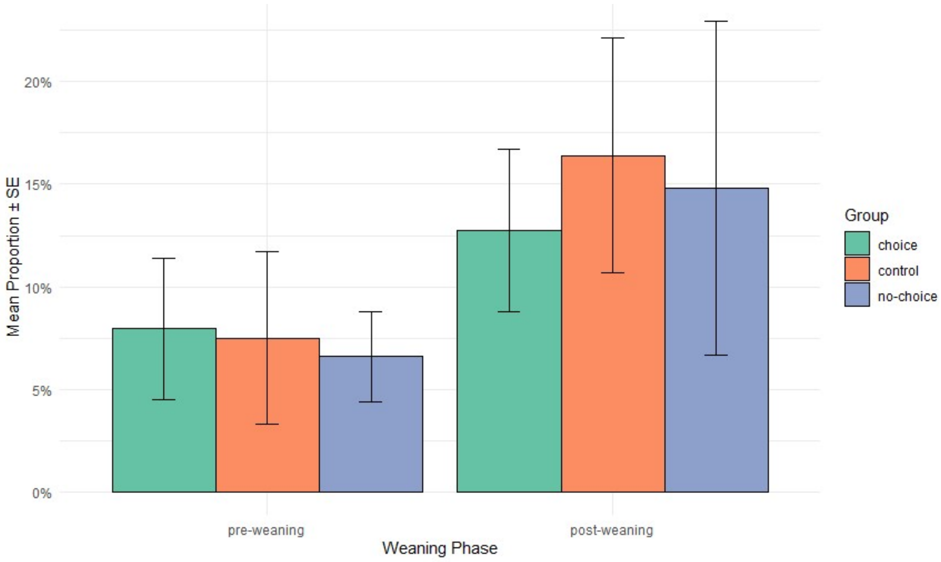

Figure 13: Mean percentages and standard errors of manure-on per observation before and after weaning (choice group n = 53; no-choice group n = 50; control group n = 50)

Table 9: Incidence of diarrhoea' statistics of piglet groups per period.

Periods	**Scored assessments**	**test**	**X^2 hypothesis test)**	**(alternative for fisher**	**df**	**p-value**
Before weaning	faeces	chi-square	5.8664		2	0.05323
	manure on	chi-square	1.9174		2	0.3834
After weaning	faeces	chi-square	3.0586		2	0.2167
	manure on	chi-square	5.0935		2	0.07834
From birth to seven weeks old	faeces	chi-square	7.9933		2	0.01838
	manure on	chi-square	2.5287		2	0.2824

4 Discussion

Results have shown that only damaging behaviours were improved by the choice and no-choice treatments. The ear and rear skin lesions issues have been significantly improved by the choice treatment, and the front lesions by the no-choice treatment compared to the control group. The choice group shows good results for ear and rear skin lesions before weaning. The no-choice has good results on the front skin lesions after weaning.

4.1 Health

Sores on knee

Forelimbs skin abrasions are very common issues. It reduces piglets' performances and increases infection risks and lameness (Heimann et al. 2024). 73% of piglets included in Heimann et al. (2024) had forelimbs skin abrasion at 5 days old. It also impacts piglets' welfare, by restraining their movements while playing and suckling. The root of this problem is the skin frictions on the floor while playing and suckling, because of the floor material. Heimann et al. (2024) included litters on plastic floors, and some others on rubber mattress. The litters on plastic floors have shown more sores on knees. Indeed, a link can be done with the Lövsta farm floor. Before weaning, between 40 and 45% of piglets had knee sores in average, depending on the group. Lövsta farm floor is mainly made of concrete, an abrasive surface.

Other issues

Snout lesions have some controversial links with lacks or restrictions of milk and artificial lactation (Chou et al. 2022). However, no measures or neither analysis of milk production per piglet were performed, and all piglets have got their sow milk and creep feed ad-libitum as base of their treatment in this field experiment at Lövsta farm. Concerning skin lesions, no analysis had got performed for knowing the roots of the problems. Most of the cases encountered were about tiny skin crusts spread over the snout, the mouth, jaws and sometimes till a bit below the eyes. The two most common skin diseases encountered in Pereira et al. (2020), are Vesicular dermatitis and Exudative epidermitis. What has been seen during the experiment were mainly cases looking alike Exudative epidermitis. No significative results have been found out about other results.

4.2 Weight gains

From a farming point of view, having heavy and healthy piglets at weaning is a gage of better transition time in early post-weaning, and piglets reaching the wanted weight faster (Collins et al. 2017). This lifetime growth performance has serious economic impacts on pig farming and industry.

The three treatment groups haven't shown any significant difference in their birth weight. That makes a reliable base for starting the experiment. The control group shows a significative advantage over the choice and no-choice groups for the weaning weight and the seventh observation weight. This can be explained by the nutritional composition of the extra-feed of the choice treatment. Some of them might don't have nutritional properties as good as the creep feed they are exposed to on a daily base (Partanen et al. 2008). It could also be linked to the limitation of enrichment in time. Choice and no-choice group piglets were exposed to the treatment twice a week, twenty times two minutes. It can enhance some stress to animals as evocated earlier with tail damages with (Godyń et al. 2019). Also, it is stated in other monogastric species alike humans (Swift et al. 2014) or horses (Gordon et al. 2009) that extra-physical activities are factors of weight loss.

4.3 Damaging behaviours

Tail issues

In the Danish study Hakansson et al. (2020), the tail wound prevalence also shows a rise from birth to the seventh week, with 2% of piglets concerned on the fourth week, and 5,6% concerned on the seventh week. That study exposes several reasons for tail biting occurrence in non-docked tail herds. The main causes are housing management, genetic, and cognitive stimulation of piglets in early life, exposition to diverse experiences. This last point is the base of this experiment based on field work. The choice group being the most exposed to diverse experiences till seven weeks of age. However, results show the control group having the lowest mean counts of tail lesions per observation, followed by the no-choice group. Such results can find roots in the time limitation of the implemented means. Godyń et al. (2019) also evocates the effects of enrichment limitations, making bounds with an increase of damaging social behaviours. In this research experiment, piglets were exposed twenty times two minutes to their treatments, twice a week in overall. Such time limitations are clearly comparable with the case evocated in Godyń et al. (2019), about negative behavioural effects among finishers having straw distributions twice a week.

Skin lesions

Results show similarities before and after weaning, but also all over the experiment. Any of these periods enlightens the significancy of ear, front body part, middle body part and rear body part of skin lesions occurrence (*Table 8*).

Considering only piglets' body in three parts as front (with ears), middle and rear (with tail), Yang et al. (2018) and Godyń et al. (2019) states: piglets having skin lesions on the front are piglet actively involved in fighting activities, and piglets with rear skin lesions are mainly piglets being bullied by their pers. However, middle skin lesions haven't shown proofs of active or passive aggressions (Turner et al., 2006). The middle part being in between the rear and the front, it might be possible this body-part being touched when front and rear are targeted in cases of either bullying or active fighting. The middle body part skin lesions don't seem to have very clear origins. In the current experimental study, results indicates that rear skin lesions are rarer than front, ears and middle skin lesions. This indicates few piglets bullied each other's, but more were actively fighting.

Fighting is unavoidable in a certain measure. The reason is it is part of pig socialisation in the aim to establish a hierarchy in the group (Ewbank & Meese, 1971). Therefore, Lövsta's farm piglets have shown hints of hierarchy settlements. Looking at the rising evolution of front, middle, and rear lesions (*Figures 9, 10, 11),* we can appreciate the decrease of mean counts of piglets without skin lesions per observation from before to after weaning. That is surely linked to weaning, the sow being removed from the pen. This step in the piglets' development shuffles their social hierarchy, constraining them to find another one out.

Only Ear lesions (*Figure 8)* have shown an increase of the piglets "0" in the choice and no-choice group. These results make sense comparing to Middelkoop et al. (2019). This study result show that piglets exposed to playful feeders before and after weaning show better farming performances, but also less ear lesions 15 days after weaning (*Figure 8)*. Moreover, the choice group shows more piglets without skin lesions than the no-choice group. The choice group being more stimulated by playful feeders and rewards than the no-choice group.

In summary, the choice group significantly shows the most piglets with fewer lesions for ear and rear skin lesions. It shows significantly more piglets without skin lesions before and after weaning. Concerning front skin lesions, the no-choice group shows more advantages compared to the choice and control groups. It has significantly more piglets without front skin lesions before and after weaning.

4.4 Incidence of diarrhoea

Faeces issues

Consistency and colour faeces issues are very common after weaning (Canibe et al. 2022). They include all what is related to odd colours and consistencies of piglets' faeces. But once again, the no-choice group reach better results for pig farming than choice group. It can find roots in the variety and quality of feeds offered to the choice group piglets. There are many nutritional factors affecting post-weaning diarrhoea (Tang et al., 2024). Few of them might be involved in this experiment results, but no investigation has been performed for knowing the faeces issues root we faced during this experiment. The chosen feeds for experiment had been selected before the pilot study for assuring relevant trials. However, piglets were exposed to five different feeds twice a week, some of them following the farm animal feed quality requirements followed at SLU's Lövsta farm (alike peat, hay, straw creep feed), and some others following Swedish human food requirement (alike cereals, fruits, popcorn, yoghurts and dairy products used in this experiment). This regular but limited exposition to new feeds can be source of constant digestive adaptations for piglets (Heo et al. 2013). It can lead faeces with unusual colour or texture.

Manure on piglets

Piglets naturally seek to eliminate faeces far away from their nest as soon as they are able to (Andersen et al. 2020). Hence, if piglets fail in this task, it means some parts of their behaviour and welfare are impaired, alike in case of diarrhoea. It can also be caused by cleanliness of the pen, the pen design, the air temperature and velocity (Ocepek & Andersen 2022). In this experiment, pens were cleaned, and straw was added every morning. Air flowing and temperature were following the usual management of Lövsta farm. That means it could be off sometimes, but this experiment didn't measure these. The only thing that might impact this result is the pen design. The Swedish legislation states that farrowing units must be loose for sows and requires having a minimum of 6 m2 per sow with its litter, including 4m2 of lying surface. This lying surface must be made of 75% of solid lying material (Jordbruksverket 2025).This area of solid material was made of concrete at SLU's premises. This keeps liquid fluids and faeces from dropping in the slurry pit through gratings and must be cleaned once a day. That job was done at farm but still made occasions for piglets to get dirty.

4.5 Limits of the experiment

This experiment has shown a few uncertain sides during field work at the pig experimental farm, and statistically.

Field work

The apply of experiment has shown limits about the feed rotation of the choice group. An actual food plan was elaborated, organising what feed the piglets of the choice group would have access at a certain day, for a certain cost (a certain weight-strength on their gate-out). It happened once or twice to have shortage of some feed and replacing it with a similar one. Also, the feed rotation was organised among the playful feeders (dog toys). Some rare days, it happened to exchange feed between two feeders because of unsuitable feed for the toys.

From our field observation, all the piglets selected for experimentation in litters didn't use to go in the extra pen. Some of them did a lot, almost every two minutes sessions, some others did very few times. More, among the piglets accessing the pen with extra-feed, some of them didn't eat the extra-feeds. Also, some piglets were more interested in some feeds that others. During the field work, the access of the piglets in the extra pen has been recorded. Yet, such data haven't been taken in account in this study. That is the topic of another study written on the same experimental setting. However, if piglets would be considered as out goers/non- out goers, or eaters/non-eaters, results might enlighten new phenomenon. For instance, some correlation between a certain weight at a certain age and the consumption of one of the 5 feed offered on a regular base could show growth improvements. Indeed, this study consider the treatment exposition as determinant over the treatment taken.

By the end of every batch, the last experimental session after weaning was supposed to be about 13,5 kg on the weighed gate. But some of the adjustable door stoppers on the gates were not powerful enough to reach that strength. Indeed, it happened often the gate strength was between 11 and 13,5 kg. From our personal observations, it didn't really alter piglet's behaviour. In such a strength range, no piglets from the no-choice group have gone out their pen, and few of the choice group did. Piglets were more likely to pass the gate at lower weight strength.

Concerning the health-checks, the scored assessments and skin lesions counting have been performed with several different people over the whole experiment. More, everything was assessed by sight, and appreciation. Even with a proper training from work field colleagues and the research supervisor, the complexity and the variety of the cases we faced led us using personal appreciation at some points.

Counted data

For counted data, the skin lesions have been categorised by ranges for statistical and reliability reasons. The main one being counting itself. Counting was performed by one person at a time, but several people all over the experiment. More, from the fifth health check piglets were observed from the scale crate, making sometimes difficult to observe and assess. Indeed, it was more reliable to consider sum of skin lesions by ranges than counts, in case one of the skin lesions was out of sight or counted twice. For the skin lesions on the front, ear and middle, categories are 0, 1-3, 4-6 and over 6. For the rear skin lesions categories are 0, 1-3 and over 3, due to the rarity of this type of skin lesions.

Statistics

This research stands on the results of 15 litters. The whole experiment comprehends 21 litters. The reason why six litters don't figure in this research is because the experiment wasn't completed by the time this thesis had to be submitted. The last batch of six litters started in early April 2025 and ended on the 13th of May 2025. The aim being to have a finalised thesis by the 28th of May 2025, the time lap for processing data and writing about results would be too short if that last batch was considered. That might impact the reliability, the significance of statistical results. However, this study is still about 153 piglets, with more than 1000 observations.

5 Conclusion

This research aimed to show the effects of the choice group, and the no-choice group compared to the control group on health, weight gain, damaging behaviours and the incidence of diarrhoea from before to after weaning.

In this experiment setting, results have shown that the choice group doesn't have beneficial effects on knee sores nor any other issues concerning health state. The weight gains and ADG haven't shown any positive results for the choice and no-choice groups. Concerning the damaging behaviours, the skin lesions have shown significant low mean percentages of low lesion counts for the choice treatment and the no-choice treatment in overall compared to the control group. The choice treatment having an advantage before weaning, and the no-choice treatment after weaning. The incidence of diarrhoea with the mean count of faeces has shown a statistical tendency before weaning, the no-choice treatment having the lowest mean counts, followed by the choice one.

Therefore, results allow to affirm the freedom of choice has proven an improvement in the decrease of some damaging behaviours. But concerning health, weight gains, and incidence of diarrhoea, results either showed a significant advantage for the control group, or no significance. The hypothesis being: '*The freedom of choice will promote growth and health during the weaning period, while also reducing damaging behaviours,'* it cannot be supported.

Some other implementations must be done for significantly improving growth, health and reducing damaging behaviours. However, the limits of the study evocated a limited number of piglets included in the statistics. Including more piglets in such research could make more significant results and maybe confirming more significant improvements.

Popular science summary

The pig and pork industries are currently facing challenges. Some of their main roots are the rise of pork consumption these lasts decades, while the quality of products required by consumers also has changed, improved. Nowadays, piglets' weaning is one of the main challenges in modern pig farming. The main problems currently occurring are enteric diseases and diarrhoea after weaning. They can have many causes. One of them is lack of stress resilience and can be solved by enriching piglets' environment. The aim being to allow them to express a bigger range of their natural behaviours at farm. For this, allowing piglets to have freedom of feed choice and foraging possibilities could show many advantages: letting them express a bigger range of their natural behaviour, while also preparing their behaviour and digestive system for a smoother transition from sow milk to a solid feed diet. More, it was interesting to require them an effort for challenging their motivation to freedom of feed choice and foraging. Therefore, we wanted to know if the freedom of feed choice and foraging combined together would have effects on piglet's health, damaging behaviour, incidence of diarrhoea and growth during lactation and after weaning.

For this, an applied experiment has got performed at the experimental farm of Funbo Lövsta, in Sweden. This applied research compared three treatments on piglets from one to seven weeks of age the weaning being at five weeks of age. The first treatment called 'free-choice' consisted in giving the possibility to piglets to going out and in their pen by a gate crafted for them, for accessing an extra-pen containing five different feeds in five different playful feeders. Piglets were exposed to such a treatment twenty time two minutes sessions, twice a week. In between the two minutes sessions, piglets were driven back to their pen, and feeders were refilled. As soon as they were refilled, the next- two minutes session started. On their way-out gate, adjustable door stoppers were set up for adding weight strength on the little door. The weight strength was set heavier and heavier experimental session day after another, on a fixed ratio. The second group treatment has had the same treatment, as a difference they had only one usual creep feed in a usual feeder at disposition in the extra-pen. The control group was raised under classic Swedish farming regulation, alike choice and no-choice groups out of experimental session times. Every Monday afternoon, piglets went through a visual health check with assessments, and weighing.

Results have shown that damaging behaviours were significantly lower for the no-choice and choice groups, concerning some types of skin lesions. The choice group having some advantages before weaning concerning ear and rear skin lesions, and the no-choice group after weaning for the front skin lesions. Concerning weight gains, incidence of diarrhoea and health, none of them showed real significant improvement over the experiment.

References

Andersen, H.M.-L., Kongsted, A.G. & Jakobsen, M. (2020). Pig elimination behavior—A review. *Applied Animal Behaviour Science*, 222, 104888. https://doi.org/10.1016/j.applanim.2019.104888

Aubé, L., Guay, F., Bergeron, R., Bélanger, G., Tremblay, G.F., Edwards, S.A., Guy, J.H. & Devillers, N. (2021). Feed restriction and type of forage influence performance and behaviour of outdoor gestating sows. *Animal*, 15 (10), 100346. https://doi.org/10.1016/j.animal.2021.100346

Bigelow, J.A. & Houpt, T.R. (1988). Feeding and drinking patterns in young pigs. *Physiology & Behavior*, 43 (1), 99–109. https://doi.org/10.1016/0031-9384(88)90104-7

Bruininx, E.M. a. M., Schellingerhout, A.B., Binnendijk, G.P., Peet-Schwering, C.M.C. van der, Schrama, J.W., Hartog, L.A. den, Everts, H. & Beynen, A.C. (2004). Individually assessed creep food consumption by suckled piglets: influence on post-weaning food intake characteristics and indicators of gut structure and hind-gut fermentation. *Animal Science*, 78 (1), 67–75. https://doi.org/10.1017/S1357729800053856

Bruininx, E.M.A.M., Binnendijk, G.P., van der Peet-Schwering, C.M.C., Schrama, J.W., den Hartog, L.A., Everts, H. & Beynen, A.C. (2002). Effect of creep feed consumption on individual feed intake characteristics and performance of group-housed weanling pigs1. *Journal of Animal Science*, 80 (6), 1413–1418. https://doi.org/10.2527/2002.8061413x

Canibe, N., Højberg, O., Kongsted, H., Vodolazska, D., Lauridsen, C., Nielsen, T.S. & Schönherz, A.A. (2022). Review on Preventive Measures to Reduce Post-Weaning Diarrhoea in Piglets. *Animals*, 12 (19), 2585. https://doi.org/10.3390/ani12192585

Chou, J.-Y., Marchant, J.N., Nalon, E., Huynh, T.T.T., van de Weerd, H.A., Boyle, L.A. & Ison, S.H. (2022). Investigating risk factors behind piglet facial and sow teat lesions through a literature review and a survey on teeth reduction. *Frontiers in Veterinary Science*, 9. https://doi.org/10.3389/fvets.2022.909401

Choudhury, R., Middelkoop, A., Boekhorst, J., Gerrits, W.J.J., Kemp, B., Bolhuis, J.E. & Kleerebezem, M. (2021a). Early life feeding accelerates gut microbiome maturation and suppresses acute post-weaning stress in piglets. *Environmental Microbiology*, 23 (11), 7201–7213. https://doi.org/10.1111/1462-2920.15791

Choudhury, R., Middelkoop, A., de Souza, J.G., van Veen, L.A., Gerrits, W.J.J., Kemp, B., Bolhuis, J.E. & Kleerebezem, M. (2021b). Impact of early-life feeding on local intestinal microbiota and digestive system development in piglets. *Scientific Reports*, 11 (1), 4213. https://doi.org/10.1038/s41598-021-83756-2

Clouard, C. & Val-Laillet, D. (2014). Impact of sensory feed additives on feed intake, feed preferences, and growth of female piglets during the early postweaning period1. *Journal of Animal Science*, 92 (5), 2133–2140. https://doi.org/10.2527/jas.2013-6809

Collins, C.L., Pluske, J.R., Morrison, R.S., McDonald, T.N., Smits, R.J., Henman, D.J., Stensland, I. & Dunshea, F.R. (2017). Post-weaning and whole-of-life performance of pigs is determined by live weight at weaning and the complexity of the diet fed after weaning. *Animal Nutrition*, 3 (4), 372–379. https://doi.org/10.1016/j.aninu.2017.01.001

CRAN Rstudio 4.4.2 (2024). *Index of /bin/windows/base/old/4.4.2. https://cran.r-project.org/.* https://cran.r-project.org/bin/windows/base/old/4.4.2/ [2025-05-25]

Day, J.E.L., Kyriazakis, I. & Lawrence, A.B. (1996). An investigation into the causation of chewing behaviour in growing pigs: The role of exploration and feeding motivation. *Applied Animal Behaviour Science*, 48 (1), 47–59. https://doi.org/10.1016/0168-1591(95)01022-X

Endrésen, E. (2024). *Sow and farrowing pen sizes in Swedish pig production*. [Second cycle, A2E]. https://stud.epsilon.slu.se/20021/ [2025-05-20]

European Council (2019). *Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs (Codified version)*. http://data.europa.eu/eli/dir/2008/120/2019-12-14/eng [2025-05-25]

Ewbank, R. & Meese, G.B. (1971). Aggressive behaviour in groups of domesticated pigs on removal and return of individuals. *Animal Science*, 13 (4), 685–693. https://doi.org/10.1017/S0003356100000179

Flis, M., Sobotka, W. & Antoszkiewicz, Z. (2017). Fiber substrates in the nutrition of weaned piglets – a review. *Annals of Animal Science*, 17 (3), 627–644. https://doi.org/10.1515/aoas-2016-0077

Genetik (n.d.). *Svenska Köttföretagen AB*. https://kottforetagen.se/grisgenetik/genetik/ [2025-06-30]

Godyń, D., Nowicki, J. & Herbut, P. (2019). Effects of Environmental Enrichment on Pig Welfare—A Review. *Animals*, 9 (6), 383. https://doi.org/10.3390/ani9060383

Gordon, M.E., Jerina, M.L., Raub, R.H., Davison, K.A., Young, J.K. & Williamson, K.K. (2009). The effects of dietary manipulation and exercise on weight loss and related indices of health in horses. *Comparative Exercise Physiology*, 6 (1), 33–42. https://doi.org/10.1017/S1478061509356169

Hakansson, F., Lahrmann, H.P. & Forkman, B. (2020). A longitudinal study of pre- and post-weaning tail damage in non-docked pigs. *Animal*, 14 (10), 2159–2166. https://doi.org/10.1017/S1751731120001081

Heimann, M., Hartmann, M., Freise, F., Kreienbrock, L. & grosse Beilage, E. (2024). Foot lesions and forelimb skin abrasions in suckling piglets: development and risk factors. *Porcine Health Management*, 10 (1), 1. https://doi.org/10.1186/s40813-023-00351-9

Heo, J.M., Opapeju, F.O., Pluske, J.R., Kim, J.C., Hampson, D.J. & Nyachoti, C.M. (2013). Gastrointestinal health and function in weaned pigs: a review of feeding strategies to control post-weaning diarrhoea without using in-feed antimicrobial compounds. *Journal of Animal*

Physiology and Animal Nutrition, 97 (2), 207–237. https://doi.org/10.1111/j.1439-0396.2012.01284.x

Hintze, S. & Yee, J.R. (2023). Animals in flow – towards the scientific study of intrinsic reward in animals. *Biological Reviews*, 98 (3), 792–806. https://doi.org/10.1111/brv.12930

Homer, B., Judd, J., Mohammadi Dehcheshmeh, M., Ebrahimie, E. & Trott, D.J. (2023). Gut Microbiota and Behavioural Issues in Production, Performance, and Companion Animals: A Systematic Review. *Animals*, 13 (9), 1458. https://doi.org/10.3390/ani13091458

Huting, A.M.S., Middelkoop, A., Guan, X. & Molist, F. (2021). Using Nutritional Strategies to Shape the Gastro-Intestinal Tracts of Suckling and Weaned Piglets. *Animals*, 11 (2), 402. https://doi.org/10.3390/ani11020402

Jackson, R.E., Waran, N.K. & Cockram, M.S. (1999). Methods for Measuring Feeding Motivation in Sheep. *Animal Welfare*, 8 (1), 53–63. https://doi.org/10.1017/S0962728600021205

Jha, R. & Berrocoso, J.D. (2015). Review: Dietary fiber utilization and its effects on physiological functions and gut health of swine. *Animal*, 9 (9), 1441–1452. https://doi.org/10.1017/S1751731115000919

de Jonge, F.H., Tilly, S.-L., Baars, A.M. & Spruijt, B.M. (2008). On the rewarding nature of appetitive feeding behaviour in pigs (*Sus scrofa*): Do domesticated pigs contrafreeload? *Applied Animal Behaviour Science*, 114 (3), 359–372. https://doi.org/10.1016/j.applanim.2008.03.006

Jordbruksverket (2025). *Skötsel och stallmiljö för grisar*. *jordbruksverket.se*. [text]. https://jordbruksverket.se/djur/lantbruksdjur-och-hastar/grisar/skotsel-och-stallmiljo [2025-06-24]

Kagel, J.H., Battalio, R.C. & Green, L. (1995). *Economic Choice Theory: An Experimental Analysis of Animal Behavior*. Cambridge University Press.

Kim, S.W., Gormley, A., Jang, K.B. & Duarte, M.E. (2024). Current status of global pig production: an overview and research trends. *Animal Bioscience*, 37 (4), 719–729. https://doi.org/10.5713/ab.23.0367

Kirkden, R.D. & Pajor, E.A. (2006). Using preference, motivation and aversion tests to ask scientific questions about animals' feelings. *Applied Animal Behaviour Science*, 100 (1), 29–47. https://doi.org/10.1016/j.applanim.2006.04.009

Korte, S.M., Olivier, B. & Koolhaas, J.M. (2007). A new animal welfare concept based on allostasis. *Physiology & Behavior*, 92 (3), 422–428. https://doi.org/10.1016/j.physbeh.2006.10.018

Microsoft Excel (2016). *Download Update for Microsoft Excel 2016 (KB4011684) 64-Bit Edition from Official Microsoft Download Center*. *Microsoft Store - Download Center*. https://www.microsoft.com/en-us/download/details.aspx?id=56547 [2025-05-25]

Middelkoop, A. (2020). *PhD Thesis Anouschka Middelkoop - Foraging in the farrowing room*. https://www.researchgate.net/publication/350957754_PhD_Thesis_Anouschka_Middelkoop_-_Foraging_in_the_farrowing_room [2025-01-30]

Middelkoop, A., Choudhury, R., Gerrits, W.J.J., Kemp, B., Kleerebezem, M. & Bolhuis, J.E. (2018). Dietary diversity affects feeding behaviour of suckling piglets. *Applied Animal Behaviour Science*, 205, 151–158. https://doi.org/10.1016/j.applanim.2018.05.006

Middelkoop, A., Costermans, N., Kemp, B. & Bolhuis, J.E. (2019). Feed intake of the sow and playful creep feeding of piglets influence piglet behaviour and performance before and after weaning. *Scientific Reports*, 9 (1), 16140. https://doi.org/10.1038/s41598-019-52530-w

Molist, F., van Oostrum, M., Pérez, J.F., Mateos, G.G., Nyachoti, C.M. & van der Aar, P.J. (2014). Relevance of functional properties of dietary fibre in diets for weanling pigs. *Animal Feed Science and Technology*, 189, 1–10. https://doi.org/10.1016/j.anifeedsci.2013.12.013

Mouttotou, N. & Green, L.E. (1999). Incidence of foot and skin lesions in nursing piglets and their association with behavioural activities. *Veterinary Record*, 145 (6), 160–165. https://doi.org/10.1136/vr.145.6.160

Mu, C., Zhang, L., He, X., Smidt, H. & Zhu, W. (2017). Dietary fibres modulate the composition and activity of butyrate-producing bacteria in the large intestine of suckling piglets. *Antonie Van Leeuwenhoek*, 110 (5), 687–696. https://doi.org/10.1007/s10482-017-0836-4

Nilsson, M. (2017). Production: Ministry of Enterprise and Innovation Printing: Elanders Item no: N2017.16.

Ocepek, M. & Andersen, I.L. (2022). The Effects of Pen Size and Design, Bedding, Rooting Material and Ambient Factors on Pen and Pig Cleanliness and Air Quality in Fattening Pig Houses. *Animals*, 12 (12), 1580. https://doi.org/10.3390/ani12121580

Olsson, I. a. S., Keeling, L.J. & McAdie, T.M. (2002). The Push-Door for Measuring Motivation in Hens: An Adaptation and a Critical Discussion of the Method. *Animal Welfare*, 11 (1), 1–10. https://doi.org/10.1017/S0962728600024271

Pajor, E.A., Fraser, D. & Kramer, D.L. (1991). Consumption of solid food by suckling pigs: individual variation and relation to weight gain. *Applied Animal Behaviour Science*, 32 (2), 139–155. https://doi.org/10.1016/S0168-1591(05)80038-3

Parois, S.P., Van Der Zande, L.E., Knol, E.F., Kemp, B., Rodenburg, T.B. & Bolhuis, J.E. (2022). A multi-suckling system combined with an enriched housing environment during the growing period promotes resilience to various challenges in pigs. *Scientific Reports*, 12 (1), 6804. https://doi.org/10.1038/s41598-022-10745-4

Partanen, K., Siljander-Rasi, H. & Alaviuhkola, T. (2008). Feeding weaned piglets and growing-finishing pigs with diets based on mainly home-grown organic feedstuffs. *Agricultural and Food Science*, 15 (2), 89. https://doi.org/10.2137/145960606778644502

Pereira, P.R., Bianchi, R.M., Hammerschmitt, M.E., Cruz, R.A.S., Hesse, K.L., Sonne, L., Pavarini, S.P. & Driemeier, D. (2020). Primary skin diseases and cutaneous manifestations of systemic diseases in swine. *Pesquisa Veterinária Brasileira*, 40, 579–588. https://doi.org/10.1590/1678-5150-PVB-6704

Pluske, J.R., Hampson, D.J. & Williams, I.H. (1997). Factors influencing the structure and function of the small intestine in the weaned pig: a review. *Livestock Production Science*, 51 (1), 215–236. https://doi.org/10.1016/S0301-6226(97)00057-2

Pluske, J.R., Kim, J.-C., Hansen, C.F., Mullan, B.P., Payne, H.G., Hampson, D.J., Callesen, J. & Wilson, R.H. (2007). Piglet growth before and after weaning in relation to a qualitative estimate of solid (creep) feed intake during lactation: A pilot study*. *Archives of Animal Nutrition*, 61 (6), 469–480. https://doi.org/10.1080/17450390701664249

Rault, J.-L., Lawrence, A.J. & Ralph, C.R. (2018). Brain-derived neurotrophic factor in serum as an animal welfare indicator of environmental enrichment in pigs. *Domestic Animal Endocrinology*, 65, 67–70. https://doi.org/10.1016/j.domaniend.2018.05.007

Regeringskansliet, R. och (2017). *A National Food Strategy for Sweden – more jobs and sustainable growth throughout the country. Short version of Government bill 2016/17:104*. *Regeringskansliet*. [Text]. https://www.government.se/information-material/2017/04/a-national-food-strategy-for-sweden--more-jobs-and-sustainable-growth-throughout-the-country.-short-version-of-government-bill-201617104 [2025-01-29]

Sampedro-Piquero, P., Begega, A. & Arias, J.L. (2014). Increase of glucocorticoid receptor expression after environmental enrichment: Relations to spatial memory, exploration and anxiety-related behaviors. *Physiology & Behavior*, 129, 118–129. https://doi.org/10.1016/j.physbeh.2014.02.048

SLU (2025). *SLU - a broad and sustainable university*. *SLU.SE*. https://www.slu.se/en/about-slu/ [2025-05-25]

Solà-Oriol, D. & Gasa, J. (2017). Feeding strategies in pig production: Sows and their piglets. *Animal Feed Science and Technology*, 233, 34–52. https://doi.org/10.1016/j.anifeedsci.2016.07.018

Špinka, M. (2019). Animal agency, animal awareness and animal welfare. *Animal Welfare*, 28 (1), 11–20. https://doi.org/10.7120/09627286.28.1.011

Stolba, A. & Wood-Gush, D.G.M. (1989). The behaviour of pigs in a semi-natural environment. *Animal Science*, 48 (2), 419–425. https://doi.org/10.1017/S0003356100040411

Swift, D.L., Johannsen, N.M., Lavie, C.J., Earnest, C.P. & Church, T.S. (2014). The Role of Exercise and Physical Activity in Weight Loss and Maintenance. *Progress in Cardiovascular Diseases*, 56 (4), 441–447. https://doi.org/10.1016/j.pcad.2013.09.012

Tang, Q., Lan, T., Zhou, C., Gao, J., Wu, L., Wei, H., Li, W., Tang, Z., Tang, W., Diao, H., Xu, Y., Peng, X., Pang, J., Zhao, X. & Sun, Z. (2024). Nutrition strategies to control post-weaning diarrhea of piglets: From the perspective of feeds. *Animal Nutrition*, 17, 297–311. https://doi.org/10.1016/j.aninu.2024.03.006

Telkänranta, H., Marchant, J.N. & Valros, A. (2016). Tear staining in pigs: a potential tool for welfare assessment on commercial farms. *animal*, 10 (2), 318–325. https://doi.org/10.1017/S175173111500172X

Thomsson, O., Sjunnesson, Y., Magnusson, U., Eliasson-Selling, L., Wallenbeck, A. & Bergqvist, A.-S. (2016). Consequences for Piglet Performance of Group Housing Lactating Sows at One, Two, or Three Weeks Post-Farrowing. *PLOS ONE*, 11 (6), e0156581. https://doi.org/10.1371/journal.pone.0156581

Tkacheva, E.S. & Medvedev, I.N. (2021). Physiological characteristics of piglets during the milk feeding phase. *IOP Conference Series: Earth and Environmental Science*, 848 (1), 012086. https://doi.org/10.1088/1755-1315/848/1/012086

Turner, S.P., Farnworth, M.J., White, I.M.S., Brotherstone, S., Mendl, M., Knap, P., Penny, P. & Lawrence, A.B. (2006). The accumulation of skin lesions and their use as a predictor of individual aggressiveness in pigs. *Applied Animal Behaviour Science*, 96 (3), 245–259. https://doi.org/10.1016/j.applanim.2005.06.009

United Nations (2015). *THE 17 GOALS | Sustainable Development*. https://sdgs.un.org/goals [2025-05-25]

Uzal, F.A., Navarro, M.A., Asin, J., Boix, O., Ballarà-Rodriguez, I. & Gibert, X. (2023). Clostridial diarrheas in piglets: A review. *Veterinary Microbiology*, 280, 109691. https://doi.org/10.1016/j.vetmic.2023.109691

Van Kerschaver, C., Turpin, D., Michiels, J. & Pluske, J. (2023). Reducing Weaning Stress in Piglets by Pre-Weaning Socialization and Gradual Separation from the Sow: A Review. *Animals*, 13 (10), 1644. https://doi.org/10.3390/ani13101644

Wallgren, T., Lundeheim, N., Wallenbeck, A., Westin, R. & Gunnarsson, S. (2019). Rearing Pigs with Intact Tails—Experiences and Practical Solutions in Sweden. *Animals*, 9 (10), 812. https://doi.org/10.3390/ani9100812

van de Weerd, H. & Ison, S. (2019). Providing Effective Environmental Enrichment to Pigs: How Far Have We Come? *Animals*, 9 (5), 254. https://doi.org/10.3390/ani9050254

Welfare Quality Network (2009). *Welfare Quality Network | Assessment Protocols*. https://www.welfarequalitynetwork.net/en-us/reports/assessment-protocols [2025-05-25]

Westin, R. (2004). *Svansbitning hos gris relaterat till individuell tillväxt och ras*. [Other]. https://stud.epsilon.slu.se/10692/ [2025-01-31]

Yang, C.-H., Ko, H.-L., Salazar, L.C., Llonch, L., Manteca, X., Camerlink, I. & Llonch, P. (2018). Pre-weaning environmental enrichment increases piglets' object play behaviour on a large scale commercial pig farm. *Applied Animal Behaviour Science*, 202, 7–12. https://doi.org/10.1016/j.applanim.2018.02.004

Young, R.J., Carruthers, J. & Lawrence, A.B. (1994). The effect of a foraging device (The 'Edinburgh Foodball') on the behaviour of pigs. *Applied Animal Behaviour Science*, 39 (3), 237–247. https://doi.org/10.1016/0168-1591(94)90159-7

Appendix

Appendix 1

Table 17 introduces the feed and playful feeder schedule used during the second batch. The day order and feed, feeder (toys) combination was the same for other batches. Every experiment session days of the batch 2 and 3, one out of the two litters of the no-choice and choice groups went under treatment.

Table 17: Calendar of the feeds and playful feeder used per experimental session days of the batch 2

day	date	Food item	Toy item
Experiment session day 1	05/11/2024	Yoghurt/qvark	lickimat
		Creep feed	Kong filled with food
		Raisins	Round orange ball
		Hay	Tray
		Oats (soaked) - mixed with yoghurt	tire
Experiment session day 2	06/11/2024	Peat	Tray
		Grapes	Straw digging
		Keso	lickimat (dairy)
		cereal (soaked)	round twisty ball filled with food
		Milk powder mixed with creep feed	dog bowl
Experiment session day 3	07/11/2024	Peat	Tray
		Grapes	Straw digging
		Keso	lickimat (dairy)
		cereal (soaked)	round twisty ball filled with food
		Milk powder mixed with creep feed	dog bowl
Experiment session day 4	08/11/2024	Tube cheese	Tray
		Banana	lickimat (mashed into mat)
		Popcorn	Kong
		Oats (soaked) - mixed with milk powder	Round organge ball (can be smeared with yoghurt or popcorn)
		Yoghurt/qvark	tire
Experiment session day 5	11/11/2024	Tube cheese	Tray
		Banana	lickimat (mashed into mat)
		Popcorn	Kong
		Oats (soaked) - mixed with milk powder	Round organge ball (can be smeared with yoghurt or popcorn)
		Yoghurt/qvark	tire
Experiment session day 6	12/11/2024	Creep feed	round twisty ball filled with food
		Raisins	dog bowl
		Hay	Tray

		Oats (soaked) - mixed with yoghurt	Kong
		Peat	Tray
Experiment session day 7	13/11/2024	Creep feed	round twisty ball filled with food
		Raisins	dog bowl
		Hay	Tray
		Oats (soaked) - mixed with yoghurt	Kong
		Peat	Tray
Experiment session day 8	14/11/2024	Grapes	round twisty ball filled with food
		Keso	Round organge ball
		cereal (soaked)	tire
		Milk powder mixed with creep feed	lickimat (dairy)
		Tube cheese	dog bowl
Experiment session day 9	15/11/2024	Grapes	round twisty ball filled with food
		Keso	Round organge ball
		cereal (soaked)	tire
		Milk powder mixed with creep feed	lickimat (dairy)
		Tube cheese	dog bowl
Experiment session day 10	18/11/2024	Banana	Kong
		Popcorn	Straw digging
		Oats (soaked) - mixed with milk powder	Round organge ball
		Yoghurt/qvark	lickimat (dairy)
		Creep feed	Tray
Experiment session day 11	19/11/2024	Banana	Kong
		Popcorn	Straw digging
		Oats (soaked) - mixed with milk powder	Round organge ball
		Yoghurt/qvark	lickimat (dairy)
		Creep feed	Tray
Experiment session day 12	20/11/2024	Raisins	Straw digging
		Hay	dog bowl
		Oats (soaked) - mixed with yoghurt	round twisty ball filled with food
		Peat	Tray
		Grapes	tire
Experiment session day 13	21/11/2024	Raisins	Straw digging
		Hay	dog bowl
		Oats (soaked) - mixed with yoghurt	round twisty ball filled with food
		Peat	Tray
		Grapes	tire

Experiment session day 14	22/11/2024	Keso	lickimat (dairy)
Experiment session day 14	22/11/2024	cereal (soaked)	Tray
Experiment session day 14	22/11/2024	Milk powder mixed with creep feed	tire
Experiment session day 14	22/11/2024	Tube cheese	Kong
Experiment session day 14	22/11/2024	Banana	Round organge ball
Experiment session day 15	25/11/2024	Keso	lickimat (dairy)
Experiment session day 15	25/11/2024	cereal (soaked)	Tray
Experiment session day 15	25/11/2024	Milk powder mixed with creep feed	tire
Experiment session day 15	25/11/2024	Tube cheese	Kong
Experiment session day 15	25/11/2024	Banana	Round organge ball
Experiment session day 16	26/11/2024	Popcorn	dog bowl
Experiment session day 16	26/11/2024	Oats (soaked) - mixed with milk powder	Tray
Experiment session day 16	26/11/2024	Yoghurt/qvark	round twisty ball filled with food
Experiment session day 16	26/11/2024	Creep feed	Kong
Experiment session day 16	26/11/2024	Raisins	Straw digging
Experiment session day 17	27/11/2024	Popcorn	dog bowl
Experiment session day 17	27/11/2024	Oats (soaked) - mixed with milk powder	Tray
Experiment session day 17	27/11/2024	Yoghurt/qvark	round twisty ball filled with food
Experiment session day 17	27/11/2024	Creep feed	Kong
Experiment session day 17	27/11/2024	Raisins	Straw digging
Experiment session day 18	28/11/2024	Hay	Tray
Experiment session day 18	28/11/2024	Oats (soaked) - mixed with yoghurt	Round organge ball
Experiment session day 18	28/11/2024	Peat	tire
Experiment session day 18	28/11/2024	Grapes	Kong
Experiment session day 18	28/11/2024	Keso	lickimat (dairy)
Experiment session day 19	29/11/2024	Hay	Tray
Experiment session day 19	29/11/2024	Oats (soaked) - mixed with yoghurt	Round organge ball
Experiment session day 19	29/11/2024	Peat	tire
Experiment session day 19	29/11/2024	Grapes	Kong
Experiment session day 19	29/11/2024	Keso	lickimat (dairy)
Experiment session day 20	02/12/2024	cereal (soaked)	Kong
Experiment session day 20	02/12/2024	Milk powder mixed with creep feed	Tray
Experiment session day 20	02/12/2024	Tube cheese	round twisty ball filled with food
Experiment session day 20	02/12/2024	Banana	dog bowl
Experiment session day 20	02/12/2024	Popcorn	Straw digging
Experiment session day 21	03/12/2024	cereal (soaked)	Kong
Experiment session day 21	03/12/2024	Milk powder mixed with creep feed	Tray

		Tube cheese	round twisty ball filled with food
		Banana	dog bowl
		Popcorn	Straw digging
Experiment session day 22	04/12/2024	Oats (soaked) - mixed with milk powder	dog bowl
		Yoghurt/qvark	lickimat (dairy)
		Creep feed	Round organge ball
		Raisins	round twisty ball filled with food
		Hay	tire
Experiment session day 23	05/12/2024	Oats (soaked) - mixed with milk powder	dog bowl
		Yoghurt/qvark	lickimat (dairy)
		Creep feed	Round organge ball
		Raisins	round twisty ball filled with food
		Hay	tire
Experiment session day 24	06/12/2024	Oats (soaked) - mixed with yoghurt	Kong
		Peat	Tray
		Grapes	Straw digging
		Keso	lickimat (dairy)
		cereal (soaked)	Round organge ball
Experiment session day 25	09/12/2024	Oats (soaked) - mixed with yoghurt	Kong
		Peat	Tray
		Grapes	Straw digging
		Keso	lickimat (dairy)
		cereal (soaked)	Round organge ball

Appendix 2

Table 4: Table used for the weekly health-check (observations) of piglets

Date: ____________ Observer: ____________

Sow ID number	Piglet ID number	Piglet experimental ID	Faeces		tear stain	Lameness	Sores on knees	Respiratory			skin lesions counts					tail (y/n)*	other**	Body-weight
			faeces	Manure on				coughing	Sneezing	Pumping	Front	middle	rear	ear	legs			
XXXXX	XXXXX	1																
XXXXX	XXXXX	2																
XXXXX	XXXXX	3																
XXXXX	XXXXX	4																
XXXXX	XXXXX	5																
XXXXX	XXXXX	6																
XXXXX	XXXXX	7																
XXXXX	XXXXX	8																
XXXXX	XXXXX	9																
XXXXX	XXXXX	10																

** please specify the health problem

*if yes, please fill out tail damage sheet