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Tail Lesions and Losses of Docked and Undocked Pigs in Different Farrowing and Rearing Systems

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Abstract: This study aimed to investigate the effects of farrowing and rearing systems on tail lesions and losses of docked and undocked pigs. Pigs from three farrowing systems: Conventional farrowing crate (FC), free farrowing (FF) and group housing of lactating sows (GH) were randomly allocated to different rearing systems: A conventional system (CONV), where the pigs were regrouped and transferred to conventional finishing pens at ten weeks of age or a wean-to-finish (W-F) system, where the pigs remained in their pens until slaughter with higher space allowance during rearing. Weekly, tail lesions and losses were assessed individually. The incidence of tail lesions was higher in undocked CONV pigs compared to undocked W-F pigs (maximum: CONV 58.01%, W-F 41.16%). The rearing system had a significant effect on tail losses at the end of finishing (CONV 67.63%, W-F 38.2%). The significant effect of the rearing system might be explained by higher space allowance during rearing and reduced regrouping stress for W-F pigs. In conclusion, farrowing systems showed no effects, but the W-F rearing system reduces the frequency of tail lesions and losses; the curves of tail lesions increased slower and stayed on a lower level, which resulted in lower losses as well.

Keywords: tail lesions; tail losses; farrowing system; rearing system; undocked pigs; docked pigs; rearing; fattening; scoring; assessment

1. Introduction

One of the most important challenges in modern pig production is tail biting [1]. It occurs in a wide range of housing systems [2]. Taylor et al. [3] describe three different types of tail biting behavior, whereby the first type can be divided into two phases: "Pre-damage" and "damage". "Pre-damage" describes a gentle and harmless chewing on the tail of another pig. The tail remains complete and does not show any lesions [1]. "Damage" results in a bleeding tail caused by dental manipulation (biting) [3]. This type could be caused by a lack of enrichment material [4]. The second type "sudden-forceful" biting is defined by grabs and yanks of the tail including partial or full loss of the tail [3,5]. This type is often caused by a lack of resources such as water or feed [6]. The third type "obsessive" tail biting is defined by repeated grabs and yanks of the tail including partial or full loss of the tail [3]. The triggering factor for this type of biting is unknown, but it may be caused by a possible genetically induced aggressiveness or the increased attraction to blood [3]. To prevent all three types of biting, the pigs which tail bite could be removed from the pen. In any case the bitten pigs need to be treated and, if necessary, also removed from the pen. The first type of tail biting might be reduced by providing suitable objects for manipulation, chewing and rooting [3,7].

Tail biting is an issue which is caused by many factors. Pigs suffering from stress may react with this abnormal behavior [8]. Included among the multiple risk factors that initiate stressful situations for the pigs are climatic and light conditions [9], sex [10], husbandry environment [11], feeding [12] and group size [13]. Climate and light conditions can cause discomfort for pigs if there is no or too strong ventilation, such as a draught, as well as poor air quality or seasonal effects of cold or heat stress [1,2,9]. Many studies state sex as an influencing factor [1,2,10]. Studies as well as farmers often detect small female animals to be the biters [10]. This may be due to the higher level of activity attributed to them, combined with their higher propensity to the ano-genital area of other pigs during the first month after weaning [1,10]. Pigs try to compensate for the stressful influences that affect them by different coping strategies. This might result in manipulation of the environment or in the biting of other pigs [14,15].

Consequently, a reduction of stressful factors and an optimization of housing conditions to increase animal welfare is a way to reduce tail biting. For example, early socialization could help the pigs to handle stressful situations better [16]. Socializing piglets early in life by mixing litters prior to weaning has long-term benefits for the social behavior [16]. After weaning, the animals form a new hierarchy more quickly. Furthermore, reduced stress levels and fewer lesions after fights were observed [16]. Thus, farrowing systems which allow an early litter mixing are advantageous.

Only free farrowing systems fully allow an early socialization with the sow and also improve the welfare of the mother [17]. Freely moving sows can act more naturally and this is enabling the piglets to be more explorative and less aggressive [11]. Further, the environment during lactation as well as additional enrichment materials positively affect the ability to adapt to a new rearing environment [17]. Group housing of sows and their litters during the suckling period is reduces agonistic interactions after regrouping, and the pigs have fewer skin lesions [18].

Especially in North America, the wean-to-finish rearing system (W-F) is used [19,20]. This means that the pigs are only moved to a new pen at weaning and then remain in the pens until the end of the fattening period [21]. In this system, pigs generally have twice the space allowance during the rearing period compared to conventional systems [19]. The W-F is designed to achieve lower rearing losses, reduced animal transport and performance enhancement, as well as reduced working time for cleaning and disinfection [19,22]. In addition, stress was lowered by reducing the number of regroupings [23]. The main problem of this housing system is the poor use of space during rearing. The fact that W-F pigs are housed in the same pen after weaning, until slaughter also means that there are difficulties with the floor construction. Currently the EU regulations for weaning and fattening pigs are difficult to combine, because the animals need different designs of slatted floors [24].

Tail docking was used to reduce tail biting for many years [1,25]. However, docking does not prevent tail biting completely and is highly discussable from the ethical point of view [1,6]. Depending on the remaining tails' length, a hypersensitivity of the nerves can initiate bitten pigs to escape [1,6]. It is controversial that tail docking also brings disadvantages like infections or provokes abnormal behavior towards other regions of the body [1].

The aim of the current study was to investigate the influence of the farrowing and rearing systems on tail lesions and losses during the rearing and fattening periods under conventional conditions, including effects of the time of socialization, contact to foreign litters, tail docking status, regrouping and rehousing.

2. Materials and Methods

2.1. Animals and Housing

Data were acquired at the research farm Futterkamp of the Chamber of Agriculture of Schleswig-Holstein between May 2016 and August 2018. During seven batches, 2271 rearing pigs (50%

docked and 50% undocked, cross-breeds of (Large White × Landrace) and (Pietrain × (Large White × Landrace)) were studied. Data were also collected during the fattening period from a total of 1228 animals randomly selected from the rearing pigs. Males were reared as intact males. Pigs were raised in three farrowing systems: Conventional farrowing crate (FC), a free farrowing system (FF) and a group housing system of lactating sows (GH) (Figure 1) [26].

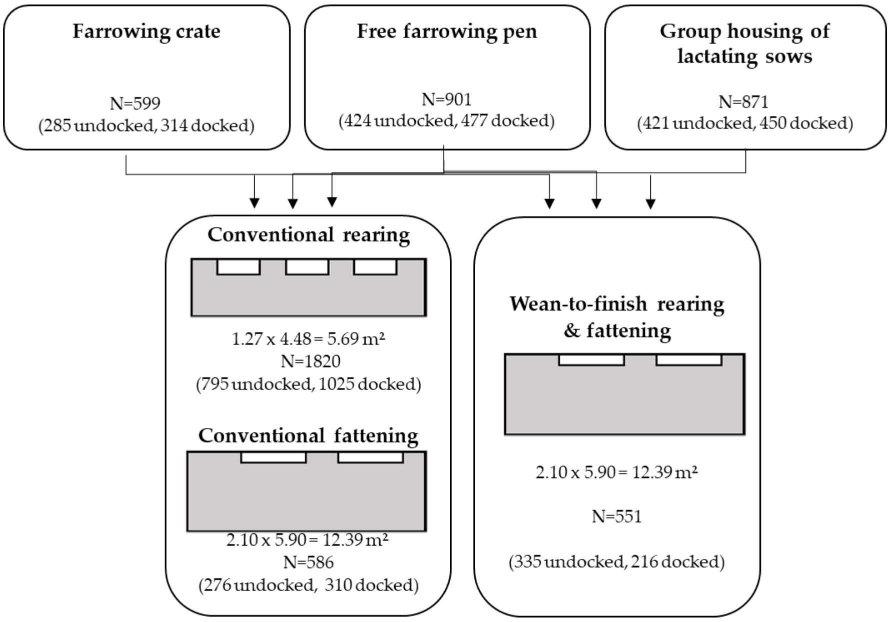

Figure 1. Experimental design (3 × 2 × 2) (3 housing systems during suckling, 2 housing systems during rearing and fatting, 50% undocked and 50% docked pigs): Overview of the indoor housing systems (N = number of pigs) [26].

The sows in the farrowing crates were single housed and their piglets had a space allowance of 5.2 m^2. For the FF and the GH animals, two sizes of farrowing pens were used for each system. This is because after two batches of the experiment, a reconstruction of the piglet nest took place. The aim was to reduce the piglet crushes, so that changes in position and architecture of the piglet nest were conducted [27,28]. The sows in the free farrowing system were single housed as well. Each FF pen had 7.0 m^2/7.56 m^2 individual space depending on the design of the piglet nest, and sows could move freely except for one batch. In this batch, the sows were fixed for three days postpartum to minimize the crushing losses of piglets. In a GH system, ten sows were housed together. They were single housed in a free-farrowing pen (6.09 m^2/5.1 m^2). All pens had an entrance for the sows and a separated entrance for the pigs to a joined running area of 30 m^2/27.5 m^2 which was offered five days postpartum for all animals.

The pigs were weaned 27 days postpartum and divided randomly within farrowing system to two types of rearing systems: Conventional rearing system (CONV rearing, 0.44 m^2/pig) and wean-to-finish system (W-F, 0.89 m^2/pig) (Figure 1). The W-F pigs were grouped single-sex and the CONV rearing were grouped mixed-sex. Pigs in the CONV rearing group were regrouped and rehoused for finishing and sorted by sex after 40 days of rearing (CONV fattening), while the W-F pigs were raised without regrouping and rehousing until slaughter (≈120 kg). The CONV fattening pigs had 0.89 m^2 per pig and their pens were identical in structure to those of the W-F pens. In CONV rearing, the pigs were housed in groups of 13 pigs on fully slatted plastic floors. In W-F, the pigs were housed in groups of 14 pigs on fully slatted concrete floors. Both systems were in the same stable. The slat width on CONV fattening and W-F pens (13 mm, tread area = 67 mm) was determined in a special permit (V242-226720/2015(8-1/16)) to allow the pigs to be kept in the same pens from weaning to the end of fattening. In summary, the study was carried out in a 3 farrowing systems × 2 rearing systems × 2 docking status design.

All pigs were fed ad libitum with conventional dry feed adjusted to their age. The feeding system started every day at 06:30 h. During the first week of rearing, the feed, which was also offered during suckling period (14.4 MJ ME/kg, 17.6% protein, 1.43% lysine, 0.24% sodium), was blended with the feed of the rearing period (13.4 MJ ME/kg, 17.0% protein, 1.30% lysine, 0.26% sodium) and fed until the end of rearing. At the beginning of fattening, after another blending of ten days, the pigs were fed a pre-fattening diet (13.4 MJ ME/kg, 16.5% protein, 1.16% lysine, 0.20% sodium) until day 100 of life. At the end of fattening, the feed was blended again and the pigs received end-fattening diet (13.2 MJ ME/kg, 15.5% protein, 1.01% lysine, 0.20% sodium) until slaughter.

All drinking systems consisted of nipples and bowls. The barn temperature during rearing and fattening was automatically regulated by forced ventilation. Artificial lighting was provided between 6:00 h and 18:00 h. The provision of the enrichment materials was defined (all treatment groups were managed following the same procedure): During the rearing period, the pigs received wood, ropes and troughs filled with peas and grass pellets. During the fattening period, they received wood and ropes. If a tail biting outbreak occurred, they got jute bags and renewed ropes and wood.

2.2. Data Collection

Starting one day after weaning, the pigs' tails were scored individually once a week until week 18 of life using a modified Schwarzenauer key, described in [29]. A tail "lesion" means that the tail has slight scratches or bite marks (score 1), a "severe lesion" shows deeper, flat lesions (score 2) and a "very severe lesion" is a deep, flat lesion which is greater than 2 cm (score 3). For the statistical analysis, the tail lesion score was summarized due to the low occurrence of severe and very severe lesions (<2%) into "no lesions" (0) and "lesions" (1) (1 summarizes score 1, 2, 3).

For the scores of tail losses, the tail was divided into quarters and then the percental loss was assessed which resulted in score 0 (intact tail) to score 4 (100% lost). For the statistical analysis, these scores were also summarized into "intact tail" and "tail loss" due to low occurrence of losses of more than 25%.

2.3. Statistical Analysis

The data analysis was conducted with SAS® 9.4 [30]. Due to the non-normally distribution of the data, the tail lesions and the tail losses were analyzed with the GLIMMIX procedure. For each parameter, the model with the lowest values for 'Akaike's information criterion corrected' (AICC) [31] and 'Bayesian information criterion' (BIC) [32] was used for further evaluation.

The model for the prevalence of tail lesions included the fixed effects rearing system (CONV, W-F), farrowing system (FC, FF, GH), docking status (undocked, docked), sex (male, female), batch (1–7), assessment week (1–18) and the interaction of assessment week*rearing system*docking status. In this study, we assumed that neither the reconstruction of the piglet nests nor the fixation of the FF sows affected the tail lesions and losses of the pigs systematically in their later life. The significance of differences in the least square means was adapted by the Bonferroni-correction to adjust for multiple comparisons. In addition, the pen was added as a random effect for consideration of the group effect.

The tail loss of the pigs was calculated in two models for the end of the rearing period (week 6) and the end of the fattening period (week 18). Both models were only calculated with undocked pigs due to the fact that docked pigs had only very few tail losses (<1%). The fixed effects rearing system (CONV, W-F), farrowing system (FC, FF, GH), sex (male, female) were included. The significance of differences in the least square means was adapted by the Bonferroni-correction to adjust for multiple comparisons. In addition, the pen was added as a random effect for consideration of the group effect.

Due to the study design and management routines it was not possible to house undocked CONV and W-F simultaneously during the fattening period. Therefore, the batch effect for the loss model was confounded with the rearing system and could not be considered separately.

3. Results

3.1. Tail Lesions

A significant effect ($p < 0.01$) of the rearing system, the docking status, the batch, the assessment week and the interaction of assessment week*rearing system*docking status on the prevalence of tail lesions was observed, while the effect of the farrowing system and sex was not significant ($p > 0.05$). The interaction of assessment week*rearing system*docking status is shown in Figure 2 and the significant differences within the assessment weeks are shown in Table 1.

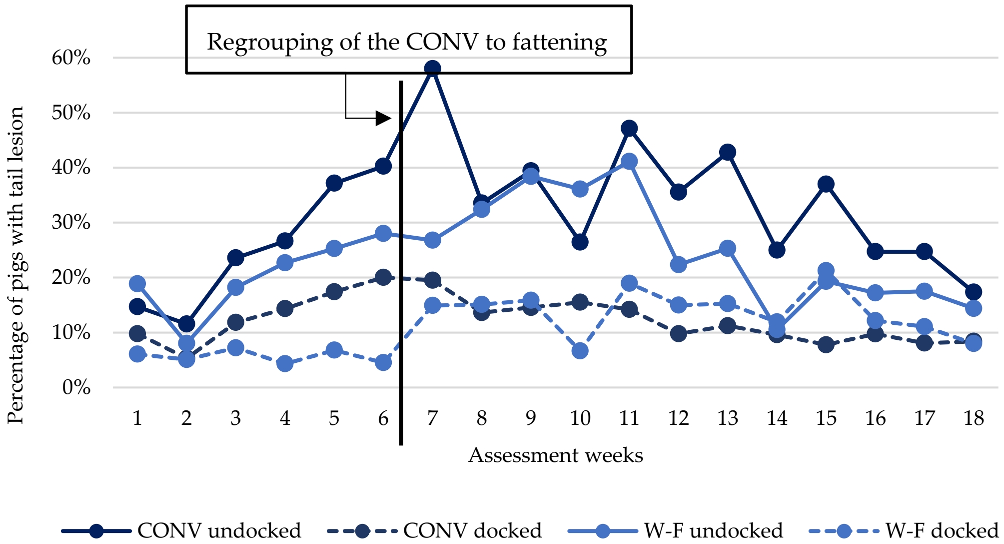

Figure 2. Frequency of back transformed tail lesion estimates during of the rearing and fattening periods for docked and undocked animals per rearing system (CONV=conventional rearing system; W-F=Wean-to-Finish rearing system).

Table 1. Multiple comparison of the Least Square-means differences of the interaction assessment week*rearing system*docking status by Bonferroni within the assessment week ($p < 0.05$).

Assessment Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CONV undocked	a	a	a	a	a	a	a	a	a	ab	a	a	a	a	a	a	a	a
CONV docked	a	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	a
W-F undocked	a	ab	ab	a	ab	ab	b	a	a	ac	a	ab	ab	ab	ab	ab	ab	a
W-F docked	a	ab	b	b	b	c	b	ab	b	b	b	b	b	ab	a	ab	ab	a

a–c: Significant differences of docking status*rearing system interaction within weeks ($p < 0.05$).

After the second assessment week, the percentage of the pigs of all treatment groups with tail lesions increased (Figure 2). The percentage of the undocked CONV pigs increased through the whole rearing period until they reach their maximum in week 7 (58.0%). After this peak, the curve took a jagged course with decreasing tendency during the fattening period. At almost all times, the prevalence of tail lesions for undocked pigs was significantly higher than for docked pigs (Table 1). The percentage of the undocked W-F pigs with tail lesions increased during the rearing period as well. This treatment group reached their maximum later, on a lower level, in week 11 (41.2%), thereafter the graph shows a decreasing tendency. From week 12 onwards, the undocked W-F animals showed no significant differences in comparison to the two docked treatment groups (Table 1). In contrast to the other groups, the docked CONV pigs reached their maximum of pigs with tail lesions at the end of the rearing period (week 6, 20.0%). The maximum prevalence of the peak of the docked W-F was only one third of the size of the undocked CONV.

The back transformed Least Square means of the batches showed a decreasing tendency over time (Figure 3). Batches 1 and 2 were nearly on the same level of tail lesions (30.0%), whereas batches 3 to 7 ranged between 19.1% and 9.5% tail lesions. Batch 6 showed the lowest values (9.5%).

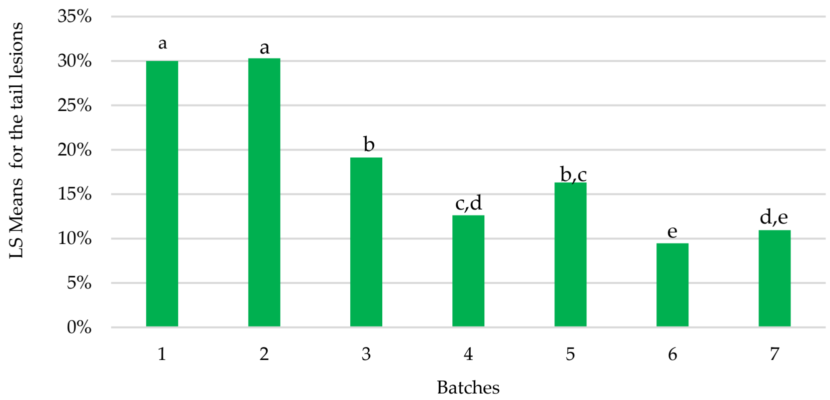

Figure 3. LS-means of back transformed tail lesion estimates of the batches. a–e: Significant differences between the batches ($p < 0.05$).

The farrowing systems only showed non-significant, numerical differences ($p > 0.05$; GH = 16.6%, FF = 17.4%, FC = 17.4%).

3.2. Tail Losses

The models of the tail losses for the end of rearing and the end of fattening periods showed comparable results. A significant effect ($p < 0.05$) of the rearing system was observed for tail losses. The effects of the farrowing system and the sex were not significant ($p > 0.05$).

At the end of the rearing period, 16.3% of the undocked CONV pigs showed tail losses (Figure 4). Only 2.9% of the W-F animals showed tail losses at the end of rearing, less than one fifth compared to the CONV animals. At the end of fattening period most of the CONV pigs lost parts of their tails (67.6%). Only 38.2% of the W-F animals lost parts of their tails. Nevertheless, the differences between CONV and W-F are significant at the end of rearing and fattening periods.

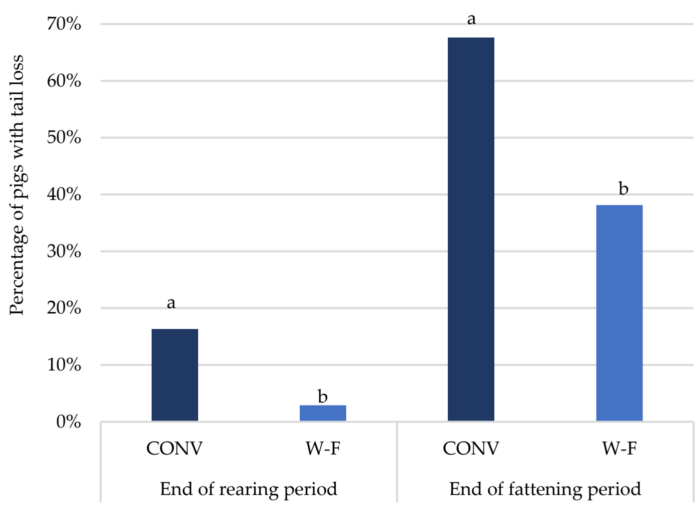

Figure 4. LS-means of back transformed tail loss estimates of the rearing systems of undocked pigs for end of rearing and end of fattening periods. a,b: Significant differences between the rearing systems within period ($p < 0.05$).

The male and female pigs showed non-significant, numerical differences ((Figure 5). At the end of the rearing period, 9.8% of the males showed tail losses (females =5.1%). At the end of the fattening period, 64.9% of the males lost parts of their tails (females 41.2%).

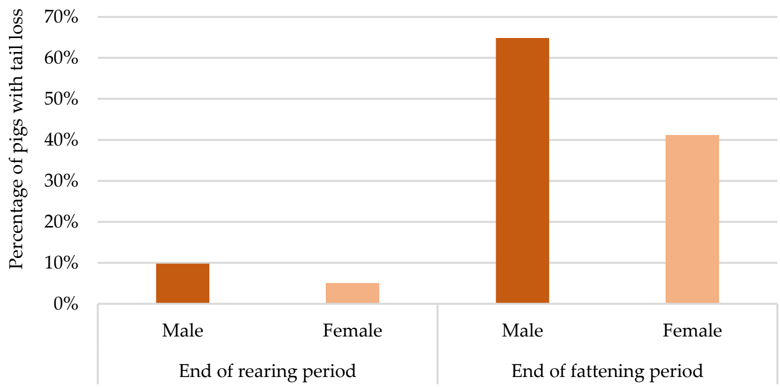

Figure 5. LS-means of back transformed tail loss estimates of the sexes of undocked pigs for end of rearing and end of fattening periods.

The differences of the farrowing systems were numerical (end of rearing period: FF = 5.8%, FC = 7.5%, GH = 8.2%; end of fattening period: FF = 51.7%, FC = 54.1%, GH = 53.7).

4. Discussion

4.1. Tail Lesions

The level of pigs with tail lesions in general, was lower in docked than in undocked pigs. Present results underline the findings of Gentz et al. [26] which referred to a subset of the present data. The paper focussed on a method to analyse an animal individual lesion parameter. This tail biting reducing function of docking is already known in the literature [1,6,25] but is ethically questionable.

In accordance with other studies [33,34] which detected an increasing number of tail lesions one week after weaning, tail lesions increased in this study in the second week after weaning for all housing and docking groups, but to different extents. Naya et al. [34] found that pigs seemed to become more courageous from the second week of age and often started to nibble and bite on boots and clothes of the observer. Tail biting may be a compensatory behavior and occurs if an animal's individual level of compensable stress is exceeded [1] The coping hypothesis proposes that stereotypies or abnormal behavior (such as tail biting) reduce the physiological stress reaction linked to environmental impacts [14,15] The peak of the undocked CONV pigs were found after regrouping to fattening, while the peak of the undocked W-F pigs was four weeks later. Thus, the CONV pigs started earlier and showed tail lesions which could be the result of coping of stress [14,15]. The undocked CONV pigs showed a sudden increase in week seven, compared to week six which was likely related to the regrouping stress and a higher aggression level [35]. The shifted start of the W-F pigs might be explained by an accumulation of stress over time, whereupon the pigs reacted with increased tail biting in week 11 [8]. These pigs did not have regrouping stress and stayed in their pens, but the W-F pigs had twice the space allowance of the CONV pigs during rearing. This advantage was obsolete during fattening, which could be stressful and might influence the shift in tail biting towards week 11 as well. Another possible explanation for the increased tail lesion level in the middle of the fattening period might be the onset of sexual maturity [36]. The animals became more restless due to hormones and their behavior changes. The housing of intact males caused more mounting behavior, this resulted in repeated irritation of wounds. The docked animals did not show clear peaks, neither in the W-F nor in the CONV, this could be explained by the fact that they may have different coping strategies than tail biting and this would be beneficial to add in the video analysis.

Taylor et al. [37] already showed the impact of a feed change on tail biting. In the current study, feed was changed and blended during weeks 1, 7 and 14 to adjust the feed to the needs of the pigs. All changes seemed to affect the pigs in the current study. The tail lesions of the undocked and docked pigs of both rearing groups increased in all three weeks, whereas the changes during week 14 seemed to specifically affect the W-F pigs.

Regarding the level of pigs with tail lesions during the 18 assessment weeks, the undocked W-F pigs were 10% lower than the undocked CONV pigs. The maximum tail lesion level of the undocked CONV pigs was 20% higher compared to the undocked W-F pigs. During the rearing period, the pen design of both systems was mainly distinguished by the floor and the space allowance (CONV: 0.44m^2; W-F: 0.89 m^2). While the CONV had plastic, the W-F animals had a concrete floor. Abriel and Jais [38] have also observed the influence of the external environment on the husbandry system in cannibalism in pigs. Already 50% more space allowance than the legal minimum requirement reduced the level of tail lesions [38].

This method of detecting tail lesions completely disregards the age of the lesion. Consequently, not all recorded lesions occurred at the current week and might be older, but refreshed and assessed previously. This study focused on analyzing the percentage of animals with tail lesions and not the percentage of animals with new lesions. To our knowledge, there is no method of tail lesion scoring which includes the evaluation of the age. To counteract this problem, it would be possible to change the frequency of the assessment and score the tails more often.

The batch effect contains all effects which were not analyzed separately. In the current study, the differences were maybe caused by learning effects of the staff. Over time, the identification of offenders has been optimized and the timing of the renewal or addition of new enrichment material has also been improved. The prevalence of tail lesions has been reduced by more intensive animal control. The batch effect can also be explained by seasonal changes in the environment. Especially the light conditions [9] differ slightly over the year.

The positive effect of early socialization [11] has not been shown to have a decisive impact. It seems to have a more important effect on skin lesions and agonistic behavior of pigs [16]. Behaviors which are associated with hierarchy and rank fights are affected by socialization [39], but tail biting is more clearly influenced by stress and space allowance in the current study.

4.2. Tail Losses

Docked pigs showed no tail losses in this study and needed to be excluded from the statistical analysis. Significant differences for undocked pigs concerning tail losses could be found in the rearing systems. These differences were evident both at the end of the rearing period and at the end of the fattening period. The fact that the W-F pigs suffered fewer losses could result from fewer lesions (average level of pigs with tail lesions CONV = 31.4%; W-F = 23.5%). In addition, tail biting was also less intense (low occurrence of severe and very severe lesions (<2%) or differently motivated [3]. As Taylor et al. [3] described, there are several types of tail biting that have different causes. Additional behavioral analysis would be beneficial to verify this. The lower percentage of tail losses of the W-F pigs might also be explained by twice the space allowance at the beginning of rearing compared to the CONV pigs, which allows for the avoidance of biting pigs.

It is noticeable that the relative percentage of tail losses was lower during rearing (6 weeks) than in the fattening period (12 weeks). Tail lesions assessed during the rearing period were almost only slight lesions of the scoring key. In the fattening period, severe or very severe lesions also occurred. Wounds differ in the healing process and often lead to losses only in the case of severe lesions. The type of tail biting could also be an explanation [3]. Possibly, the biting behavior consisted of rather playful chewing during rearing and more aggressive biting during fattening. Additionally, the agonistic interactions in the middle of the fattening period increase with the onset of sexual maturity [34]. The animals start to mount each other, and lesions lead to losses directly. It might be advantageous to score the pigs tails more often in further studies. The direct link between tail lesions and losses confirms that the recording of tail losses in the slaughterhouse is representative for the assessment of tail biting.

The tail losses of male and female pigs were not significantly different in this study. Female pigs had more intact tails and fewer losses than the males. Zonderland et al. [10] and Stratham et al. [12] already detected a significant influence of the sex for tail biting. Female pigs have suffered fewer lesions and losses in these studies.

5. Conclusions

The results show that the rearing system affected the tail lesions and losses in the current study. The higher space allowance of the W-F pigs during the rearing period compared with CONV had a positive effect. The W-F curves of tail lesions increased slower and stayed on a lower level which might be caused by a lower stress level due to reduced regrouping. Nevertheless, it must be mentioned that the largest differences were found between docked and undocked pigs. Further optimization of housing systems to avoid tail biting as well as other tail biting abnormalities for rearing and fattening of pigs are necessary.

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