More tail lesions among undocked than tail docked pigs in a conventional herd

Lahrmann, HP; Busch, ME; D'Eath, RB; Forkman, B; Hansen, CF

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Corresponding Author:	Christian Fink Hansen, Ph.D. University of Copenhagen Frederiksberg C, DENMARK
First Author:	Helle P Lahrmann
Order of Authors:	Helle P Lahrmann
	Marie E Busch
	Rick B D´Eath
	Björn Forkman
	Christian Fink Hansen, Ph.D.
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Abstract:	The vast majority of piglets reared in the EU and worldwide is tail docked to reduce tail biting, even though the EU animal welfare legislation bans routine tail docking. Some well-managed farms experience very low levels of tail biting among tail docked pigs. At this point, there is little scientific evidence regarding the effect of tail docking on tail biting prevalences in these kinds of conventional farms. The aim of this study was therefore to compare the prevalence of tail injuries between docked and undocked pigs in such a well-managed conventional piggery in Denmark where pigs in usual practice were tail docked. This study included 1922 DanAvl Duroc × (Landrace × Large White) pigs (962 docked and 960 undocked). Docked and undocked pigs were housed under the same conditions, but in separate pens within the same stable. Pigs had ad libitum access to commercial diets in a feed dispenser. Straw was provided daily on the solid floor (10 g per pig per day), and each pen had two vertically placed soft wood sticks. Pigs were individually earmarked and gender was determined just before weaning. The stockpersons recorded antibiotic treatments, pigs moved to hospital pens and euthanized pigs. From weaning to slaughter, a trained technician recorded tail damages (injury severity and freshness) every second week. No tail damages were observed within the tail docked group, whereas 23.0% of the undocked pigs got tail bitten. On average, 4.0% of the pigs had a tail lesion on tail inspection days. The results showed more pens with pigs weighed 30-60 kg with tail lesions (34.3%; $P < 0.05$) than in pens with pigs weighing 7-30 kg (13.0%) and 60-90 kg (12.8%). Furthermore, more undocked pigs had to be moved to a hospital pen ($P<0.05$). Finally, abattoir meat inspection data revealed more tail biting remarks in the undocked group ($P<0.001$). In conclusion, this study suggests that housing pigs with intact tails even in well- managed conventional herds will increase the prevalence of tail bitten pigs considerably, and pig producers will need more hospital pens. Furthermore, the abattoir data indicate that meat inspection data severely underestimate the number of pigs experiencing to be tail bitten during the rearing period.
Suggested Reviewers:	Sandra Edwards University of Newcastle sandra.edwards@ncl.ac.uk Professor Sandra Edwards has substantial research experience with the influence of

	environmental enrichment on pig behavior and welfare.
	Paul Hemsworth University of Melbourne phh@unimelb.edu.au Professor Paul Hemsworth is the Director of the Animal Welfare Science Centre at the University of Melbourne and has considerable research interest with different aspects of pig behavior and welfare.
	Marion Kluivers-Poodt Wageningen Universiteit marion.kluivers@wur.nl Drs. Marion Kluivers-Poodt has substantial research experience with in tail biting
Opposed Reviewers:	Lene J Pedersen Lene J. Pedersen is involved in on-going research investigating environmental enrichment for growing-finishing pigs in Denmark. This has led to a dispute with the management of the Pig Research Centre. As several authors of this paper are employed by the Pig Research Centre this could potentially influence her review of the submitted manuscript negatively.
	Karen Thodberg Karen Thodberg is involved in on-going research investigating environmental enrichment for growing-finishing pigs in Denmark. This has led to a dispute with the management of the Pig Research Centre. As several authors of this paper are employed by the Pig Research Centre this could potentially influence her review of the submitted manuscript negatively.
	Anna Valros Anna Valros is involved in on-going research investigating environmental enrichment for growing-finishing pigs in Denmark. This has led to a dispute with the management of the Pig Research Centre. As several authors of this paper are employed by the Pig Research Centre this could potentially influence her review of the submitted manuscript negatively.

More tail damage among undocked than tail docked pigs in a well-managed conventional herd

H. P. Lahrmann[1], M.E. Busch[1], R.B. D´Eath[2], B. Forkman[3] and C.F. Hansen[3]

[1]SEGES, Danish Pig Research Centre, Axeltorv 3, 1609 Copenhagen V, Denmark; [2]SRUC, West Mains Road, Edinburgh EH9 3JG, UK; [3]Department of Large Animal Sciences, University of Copenhagen, Grønnegårdsvej 8, 1870 Frederiksberg, Copenhagen, Denmark

Corresponding author: Christian Fink Hansen. E-mail: cfh@sund.ku.dk

Short title: Tail docking and tail damage prevalence

Abstract

The vast majority of piglets reared in the EU and worldwide is tail docked to reduce tail biting, even though the EU animal welfare legislation bans routine tail docking. Some well-managed farms experience very low levels of tail biting among tail docked pigs. At this point, there is little scientific evidence regarding the effect of tail docking on tail biting prevalences in these kinds of conventional farms. The aim of this study was therefore to compare the prevalence of tail injuries between docked and undocked pigs in such a well-managed conventional piggery in Denmark where pigs in usual practice were tail docked. This study included 1922 DanAvl Duroc × (Landrace × Large White) pigs (962 docked and 960 undocked). Docked and undocked pigs were housed under the same conditions, but in separate pens within the same stable. Pigs had *ad libitum* access to commercial diets in a feed dispenser. Straw was provided daily on the solid floor (10 g per pig per day), and each pen had two vertically placed soft wood sticks. Pigs were individually earmarked and gender was determined just before weaning. The stockpersons recorded antibiotic treatments, pigs moved to hospital pens and euthanized pigs. From weaning to slaughter, a trained technician recorded tail damages (injury severity and freshness) every second week. No tail damages were observed within the tail docked group, whereas 23.0% of the undocked pigs got tail bitten. On average, 4.0% of the pigs had a tail lesion on tail inspection days. The results showed more pens with pigs weighed 30-60 kg with tail lesions (34.3%; $P < 0.05$) than in pens with pigs weighing 7-30 kg (13.0%) and 60-90 kg (12.8%). Furthermore, more undocked pigs had to be moved to a hospital pen ($P<0.05$). Finally, abattoir meat inspection data revealed more tail biting remarks in the undocked group ($P<0.001$). In conclusion, this study suggests that housing pigs with intact tails even in well- managed conventional herds

will increase the prevalence of tail bitten pigs considerably, and pig producers will need more hospital pens. Furthermore, the abattoir data indicate that meat inspection data severely underestimate the number of pigs experiencing to be tail bitten during the rearing period.

Keywords: pigs, tail biting, tail docking, housing, behaviour

Implications

Most growing pigs within the EU are tail docked to prevent tail biting. Tail docking is a painful procedure, but so is tail biting to the bitten pigs. Even on well-managed farms tail biting may occur among tail docked pigs from time to time. Our results indicate that even in a well-managed conventional herd, more pigs will get tail bitten and more hospital pens are needed for tail bitten pigs than if they are not tail docked. We also found that abattoir estimates of tail biting prevalence are likely to greatly underestimate on-farm prevalence.

Introduction

The majority of pigs reared worldwide are tail docked to reduce tail biting (EFSA, 2007). This is also the case in the EU despite animal welfare legislation banning routine tail docking (2001/93/EC amendments to directive 91/ 630/ EEC). Despite the tail docking procedure, tail lesions still occur, variously suggested as affecting around 1-2% (Zonderland *et al.*, 2011a) or 3.1% (D'Eath *et al.*, 2016) of pigs. If pigs are to be housed with undocked tails in existing housing systems within the EU, it will most likely lead to a dramatic increase in tail bitten pigs (EFSA, 2014). A 50% increase in severe lesions has been suggested (Valros and Heinonen, 2015), and recent calculations stated 17% tail bitten pigs during growth, if pigs are to be housed with undocked tails in today's conventional systems (D'Eath *et al.*, 2016). On the other hand Finnish farmers, producing pigs with intact tails, reported in a survey average tail lesion prevalences of 2.3% (median 1%, range 0 - 30%) on farm (Valros *et al.*, 2016). However, these estimates need further evidence-based confirmation. In most studies, levels of tail damage across herds were estimated based on recordings made on pigs at slaughter (Valros *et al.*, 2004, Harley *et al.*, 2012, Keeling *et al.*, 2012). However, using abattoir meat inspection recordings to determine the level of tail bitten pigs in herds will probably underestimate the number of bitten pigs (Keeling *et al.*, 2012).

The first step towards a general termination of tail docking is therefore to investigate the consequences of housing undocked pigs in conventional herds with high-level management, high health status and low levels of tail biting among tail docked pigs. Based on existing knowledge and risk factors related to tail biting (Taylor *et al.*, 2012), it could rightly be assumed that tail biting will be less prevalent in such herds. Consequently, if tail biting increases significantly in well-managed herds, it will most likely be very difficult to house pigs with undocked tails in other herds as well without a dramatic increase in tail bitten pigs. The aim of the present study was therefore to compare the level of tail biting between pens with docked and undocked pigs in a herd with low occurrence of tail biting among tail docked pigs and high-level management.

Material and methods

This study was conducted in accordance with the guidelines of the Danish Ministry of Justice Act no. 382 (June 10,1987), Act no. 333 (May19,1990), Act no. 726

(September 9,1993) and Act no. 1016 (December 12, 2001) with respect to animal experimentation and care of animals under study.

The study was carried out at a commercial Danish farm (Vrå, Denmark) with high-level management (high health status, high growth rate, low mortality, well-functioning stables) from March 2014 to August 2015. The experimental farm was considered a low-risk herd as regards to tail biting (Taylor *et al.*, 2012).

Housing and experimental design

In total 960 undocked and 962 docked (906 females, 948 castrated males and 68 unknown gender) Danish Duroc × (Landrace×Yorkshire) pigs from 12 batches were included in the study: 47 pens with undocked tails and 48 pens with docked tails. In each pen 20.4 (+/- 1.1) pigs were randomly allocated to each experimental pen housing undocked and docked pigs separately. Two weeks after arrival, the farmer moved one or two of the smallest pigs from each pen to a buffer pen.

Piglets were born in conventional farrowing crates at a different location. Every fifth week a batch of 10-18 litters were randomly allocated to one of two treatments: tail docked or undocked. On the day of parturition piglets had the sharp tips of their needle teeth removed by grinding. At 4 days of age, the piglets of the "docked group" were tail docked (half the tail). All piglets were given iron injections (Uniferon, Pharmacosmos, Holbæk, Denmark) and male piglets were surgically castrated and given a short-term analgesic. From 10 days of age piglets were offered solid creep feed on the floor.

All pigs were ear tagged and their gender noted one week before weaning. Piglets were weaned averagely 4 weeks after birth and moved to a stable, where they were housed for 2 days before transport to the experimental farm. Docked and undocked pigs were housed separately. Within the group, pigs were allocated randomly to the pens. Pens were designed with two climate zones, with solid floor and a cover in the lying area and slats in the dunging area. Pigs had *ad libitum* access to a diet based on spring barley, wheat, fat and 30% concentrate (Danstart VP30, Vilomix, Mørke, Denmark). Furthermore, each pen was equipped with two vertical wooden laths standing on floor in a plastic retainer as enrichment.

The experimental farm consisted of four identical sections with 36 pens per section. 6-13 pens per section were included in the study. Pens measured 2.4 x 5.0 m with 4.8 m^2 solid floor and 7.2 m^2 slatted floor (Figure 1). A 2.16 m^2 cover was placed one meter above the solid floor. Two pens shared a dry feed dispenser with two nipple drinkers (Figure 1). Two vertically wooden laths standing on the floor in a retainer were positioned 0.4m apart on the pen wall between the feed dispenser and the covering.

Climate

The indoor climate at the experimental farm was regulated by a negative pressure ventilation system (SKOV A/S, Glyngøre, Denmark) supplemented with ceiling air inlets. The air inlets opened when the room temperature was 2°C above the set temperature. At weaning (day 0) the set room temperature was 24°C, and the temperature was gradually decreased during the growing period to 17°C on day 112 when the study ceased. Two heating pipes placed along the wall in either side of the section were regulated by the ventilation system. In addition, floor heating in the lying area was turned on when the pigs arrived. The floor heating was normally turned off around day 25.

Feeding

Pigs were fed with five different commercial compound diets (Table 1) formulated to fulfill the Danish recommendations for pigs of this weight and genotype (Tybirk *et al.*, 2016). From 7-9 kg (~10 days) pigs were floor fed 4 times a day (*semi ad libitum*). From ~ 9 kg until slaughter pigs had *ad libitum* access to feed in the dry feed dispenser.

Table 1 about here

Management

Each day pigs were inspected twice: at around 0900 and 1730. Pigs' health conditions were monitored, and pigs with clinical signs of disease were treated with antibiotics. The stockpersons continuously recorded pigs treated with antibiotic on pen or individual level (depending on the disease). Throughout the study period, pigs were treated for diarrhea, tail lesions, locomotion disorders, respiratory diseases, brain/nerve disorders and other reasons (none of the above mentioned). Unthrifty pigs, pigs with locomotion disorders or serious tail lesions (more than half the tail missing for undocked pigs) were either euthanized or moved to hospital pens. The farmer recorded the reason for euthanasia/death and transfer to hospital pens.

Daily, pens were provided with ~230 g of chopped wheat straw on the floor, until the pigs reached an average weight of approximately 70 kg. In case the solid floor got soiled due to defecation, the stockpersons stopped providing straw earlier.

Tail biting management

If tail biting occurred, a Bite-Rite (Ikadan Systems A/S, Ikast, Denmark), consisting of four elastic plastic sticks, was suspended in the middle of the pen above the slatted floor, and the amount of chopped straw provided was doubled (~460 g/pen, once daily). The development in tail damages was closely monitored the following days, and pigs with severe tail injuries were moved to a hospital pen.

Tail damage scoring

The degree of tail damage was recorded every second week from weaning till slaughter according to the scale in Table 2 using four parameters – tail damage, tail length, wound freshness and tail swelling. In order to standardize observations, tail scoring was performed by the same trained person throughout the study period. At tail scoring the observer was standing in the middle of the pen checking each tail.

Table 2 about here

Statistical analysis

The statistical analysis was performed using SAS Enterprise Guide 7.1. Pigs moved to hospital pens, pen level prevalence of tail damage and antibiotic treatments were analyzed with pen as the experimental unit and pen as random effect within batch. For the overall appearance of tail bitten pigs, each individual pig was the experimental unit. In these analyses, pigs within pens within batches were included as random effects. Furthermore, number of dead pigs was analyzed on batch level.

Pigs were categorized as either a tail biting victim or non-victim (binary variable). Pigs scored with a fresh or healing tail wound were categorized as victims.

Pigs were split into three weight (age) classes: (1) weaning (7-30 kg, 5-12 weeks), (2) grower (30-60 kg, 13-17 weeks) and (3) finisher (60-90 kg, 18-21 weeks) in order to compare prevalence of tail biting in different weight (age) classes.

The effect of weight (age) on tail damage prevalence was analyzed using the Generalised Linear Mixed Model procedure (GLIMMIX), with weight as fixed effect and sex, batch and pen as random effects. Differences in pigs moved to hospital pens, dead pigs and antibiotic treatments between docked and undocked pigs were analyzed using a Students t-test. Finally, a chi-square test was used to analyze slaughter data comparing tail biting remarks between docked and undocked pigs. P-values lower than 0.05 were considered significant.

Results

No tail injuries were recorded among tail docked pigs. In contrast, 220 undocked pigs distributed in 32 pens were observed with a tail wound at least once during the study period. Twenty-one tail bitten pigs (9.5%) were moved to hospital pens due to tail damage, and three tail bitten pigs (1.5%) were moved for other reasons. Thus, 89.0% of the tail bitten pigs stayed in the home pen, and the wound healed with the use of Bite-Rite and extra straw as enrichment. Furthermore, three tail bitten pigs moved to a hospital pen had to be euthanized.

Of the 220 tail bitten pigs, 38 were logged twice with a tail lesion in the home pen, and 4 were listed with a tail lesion three times. Injuries on pigs with 2 or 3 tail lesion recordings could either be a new fresh wound or a healing wound. Overall, the risk of being recorded with a tail lesion once, twice or three times during the study period was 18.5%, 4.0% and 0.4%, respectively.

On average, 4.0% (CL; 2.6 - 5.3) of the pigs had a tail lesion on an observation day. These bitten pigs were distributed in 20.9% (CL; 16.6 - 25.3) of the pens. In addition, 50.0% of the tail bitten pigs were observed within the first 37 days (~25 kg) in the pen. The recorded tail scores are listed in Table 3. By far the most frequent score (93.8%) was ‘part of the tail missing with a healing wound’.

Table 3 about here

More castrated males got tail lesions (124; P<0.001; F= 13.04) compared to gilts (82) with information about gender missing for 14 of the tail bitten pigs. More pigs had tail lesions in the weight interval 30-60 kg than 7-30 kg (P=0.026) and 60-90 kg (P<0.001). Furthermore, fewer pigs between 60-90 kg compared to 7-30 kg (P<0.001) were observed with tail lesions (Table 4). At pen level, tail lesions were more often present in pens with pigs weighing 30-60 kg than in pens with pigs weighing 7-30 kg (P<0.001) and 60-90 kg (P<0.001) (Table 4).

Table 4 about here

Further, more pigs with undocked tails had to be moved to hospital pens (P=0.03; Table 5). Undocked pigs were mainly moved to hospital pens due to the following reasons: tail damage (61.5%), other reasons (12.8%), brain/nerve disorders (10.3%), locomotion disorders (7.7%), and diarrhoea (7.7%). For docked pigs the reasons were: brain/nerve disorders (40.0%), other reasons (26.7%), diarrhoea (13.3%), locomotion disorders (13.3%) and respiratory disease (6.7%). No difference in dead or euthanized pigs was observed between docked and undocked pigs, but more pigs with undocked tails were treated with antibiotics (P=0.02; Table 5).

Finally, more pigs with undocked tails got a tail biting remark during standard meat inspection at the abattoir (P<0.001; Table 5).

Table 5 about here

Discussion

This study was designed to compare the tail biting prevalence between docked and undocked pigs from weaning to slaughter under well-managed conventional farm conditions in Denmark. In this study, none of the tail docked pigs got tail lesions, which further supports the idea that tail docking is effective at reducing damaging tail biting behavior (Sutherland and Tucker, 2011). The effect of tail docking found in the current study is in agreement with most other studies. Di Martino *et al.* (2015) reported increased risk of tail lesions among undocked fattening pigs (OR=20.82) compared to tail docked, and Sutherland *et al.* (2009) described more severe tail lesions among undocked pigs. In a survey of Dutch farmers, conventional farmers rearing tail docked pigs agreed that tail docking is the most effective way to reduce tail biting (Bracke *et al.*, 2013), although this need for tail docking received less support from Finnish conventional farmers rearing pigs with undocked tails (Valros *et al.*, 2016), with only 21% saying they would tail dock if it was permitted.

The prevalence of bitten pigs varies greatly between studies. Di Martino *et al.* (2015) observed 18.6% finishers with mild tail lesions (bite marks/small abrasions), and 3.6% with tail wounds. On the other hand, a Dutch study with undocked weaners reported considerably higher levels of tail injuries as 54% of the pigs were observed with tail wounds and 35% with bite marks (Zonderland *et al.*, 2011b). In another study 83.4% (barren environment) and 45.3% (enriched environment) of the undocked pigs were reported with a tail wound from weaning to slaughter (Ursinus *et al.*, 2014). This suggests that increasing levels of enrichment reduce the level of tail damage. Among finishers weighing 90-100 kg, Cagienard *et al.* (2005) observed 2.8% pigs missing a part of the tail on 'animal friendly' farms due to tail biting compared to 21.9% on traditional farms. In the present study, pigs were provided with straw daily, which might explain the lower level of tail bitten pigs throughout the growing period compared to some other studies. Overall, the large variation between studies is probably due to variation in any or all of the many distinct risk factors associated with tail biting (Schrøder-Petersen and Simonsen, 2001, D'Eath *et al.*, 2014), different age groups (weaner or finishers) and might also be due to different definitions of the factors that constitute a tail wound.

Stocking density has been suggested as another risk factor influencing tail biting prevalence (D'Eath *et al.*, 2014). Two epidemiological studies concluded that increasing stocking density was associated with an increased risk of tail biting (Moinard *et al.*, 2003, Scollo *et al.*, 2016). In our study, pigs were housed in the same pen from weaning to slaughter causing a lower stocking density during the weaning period (~0.6 m^2 per pig) than normally seen in conventional European herds (0.3 m^2 - EU Council Directive 2008/120/EC). Thus, stocking density might influence tail biting, but more experimental studies are required to estimate the effect.

Barrows are often more likely to become tail biting victims (Wallgren and Lindahl, 1996, Kritas and Morrison, 2004, Valros *et al.*, 2004), and this is in line with the present study. However, some experiments have failed to show a correlation between gender and the risk of becoming a tail biting victim (Sinisalo *et al.*, 2012, Scollo *et al.*, 2013, Di Martino *et al.*, 2015). These inconsistencies between studies might be attributed to different grouping strategies and different settings (Sinisalo *et al.*, 2012). The reasons why barrows in some studies more often become tail biting victims are not fully understood.

We scored evidence of damaging tail biting behaviour in every age group from weaning to slaughter, which is in accordance with a Dutch study (Ursinus *et al.*, 2014). In the Dutch study, the percentage of bitten pigs did not decline towards the end of the finisher period in a barren environment. However, a decline in tail bitten pigs in the end of the finisher period, as in our study, was observed among pigs housed in an enriched environment.

When tail biting occur the severity of tail wounds can differ between pigs in the same pen. Some pigs only get a bite mark, whereas others get actual wounds (Zonderland *et al.*, 2011b). The severity of the wound is expected to affect the healing duration. In our study, 11 pigs got a severe tail lesion with infections (swollen tail) in the home pen. This number would probably be higher if pigs moved to hospital pens were tail scored as well, but this was not the case. In comparison, 89% of the tail wounds healed successfully in the home pen between two tail inspections. The intervention, when tail damage occurred, was doubling the amount of straw and hanging up a Bite-Rite. These results indicate that it is not necessary in every case to move bitten pigs to other pens in order to stop the damaging tail biting behaviour. However, there is a need for more experimental studies looking into the tail wound healing duration using different intervention strategies as suggested by D'Eath *et al.* (2014).

Previous studies have failed to discover differences in mortality between undocked and tail docked pigs (Scollo *et al.*, 2013, Di Martino *et al.*, 2015), which corresponds with our findings. However, in contrast to our findings, no differences in the number of pigs moved to hospital pens between docked and undocked pigs were reported by Scollo *et al.* (2013) and Di Martino *et al.* (2015). A likely explanation for the dissimilarity between studies could be different management routines and strategies in the experiments.

To our knowledge, the current study is the first to compare abattoir meat inspection data between undocked and docked pigs originating from the same piggery. When comparing the percentage of pigs scored with a tail lesion on the farm (Table 4) with abattoir tail damage recordings (Table 5), our results indicate that abattoir recordings heavily underestimate the number of undocked pigs experiencing being tail bitten from weaning to slaughter. The prevalence of tail biting was highest between 30-60 kg, and these wounds probably healed before slaughter. Healed tail lesions will normally not be recorded during meat inspection, and the severely bitten pigs will in many cases be culled in the herd (Taylor *et al.*, 2010), which might explain the differences in prevalence.

Furthermore, a Danish abattoir survey of 1,173,213 tail docked pigs reported 0.85% tail damages during meat inspection (Alban *et al.*, 2015), and an Irish abattoir study with 99% tail docked pigs reported 1.03% severe tail lesions (Harley *et al.*, 2012). As expected, these figures were slightly higher than for the docked group, because the trial herd for our study was selected based on low tail biting abattoir remarks among tail docked pigs. In addition, meat inspection data from a Swedish survey (15,068 pigs) with undocked pigs showed tail damage prevalences of 1.2% and 1.6% at two different slaughterhouses (Keeling *et al.*, 2012), which is in accordance with the level found in the present study in the undocked group. In agreement, a Finnish abattoir study reported 1.3% of pigs with tail damage, though some pigs may have been tail docked (Valros *et al.*, 2004). Although no tail damage was observed among tail docked pigs during the trial period of the present study, a few tail docked pigs did get a tail biting remark at the abattoir. Perhaps tail damage occurred after the study ended, during transportation or in the abattoir holding pens.

In conclusion, this study showed that many pigs got tail bitten if they were not tail docked, even in a well-managed herd with low stocking density in the weaning period. At pig and pen level tail lesions were more prevalent among 30-60 kg pigs, than in the late finishing period from 60-90 kg. Intact tails did not increase the mortality rate. However, more pigs had to be treated with antibiotics and moved to hospital pens. In particular, the results suggest that caution should be taken when recordings from the routine meat inspection at the abattoir are used to evaluate the level of tail biting in a herd, because they probably highly underestimate the number of bitten pigs.

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Table 1 *Potential physiological energy, crude protein and lysine content in commercial diets*

Live weight	7- 9 kg[1]	9-17 kg[2]	17- 35 kg[3]	35- 55 kg[4]	55- 90 kg[5]
Potential physiological energy, MJ	8.5	7.9	7.8	7.9	7.7
Crude protein, %	18.4	17.7	18.3	16.5	14.7
Lysine,%	1.3	1.2	1.2	1.0	0.88

[1] Hedegaard A/S, Nørresundby, Denmark, Minigris L-3
[2] Hedegaard A/S, Nørresundby, Denmark,Maxigris L-7
[3] Hedegaard A/S, Nørresundby, Denmark,Maxigris voks
[4] Hedegaard A/S, Nørresundby, Denmark,Svine-voks primo
[5] Hedegaard A/S, Nørresundby, Denmark,Svine-voks sludeal

Table 2 *Tail biting scores (modified after Kritas and Morrison (2004) and Zonderland et al. (2008))*

	Description
Tail damage	
No	No visible tail lesion. Earlier lesion is healed.
Red, clean and/or minor scratches	Red, clean and/or minor scratches
Tail wound	Visible wound
Tail length	
Intact	Full length tail
Part missing	A part is missing or structural changes appears
Wound freshness	
Fresh/ bleeding	Fresh blood is visible
Dried/ scab	Wound covered with a scab
Swelling	
No	No swelling
Yes	Swollen red tail indicating an infection

Table 3 Tail scoring frequency and distribution (%)

Tail scores	n	%
Full length tail, scratches	1	0.39
Full length tail, fresh wound and swollen tail	1	0.39
Part missing and fresh wound	3	1.17
Part missing and healing wound	241	93.8
Part missing, healing wound and swollen tail	11	4.28

Table 4 *Percentage of pigs and pens with tail lesions among pigs with undocked tails in three weight intervals: 7-30 kg, 30-60 kg, 60- 90 kg.*

	7-30 kg		30-60 kg		60-90 kg		
	Mean	CL	Mean	CL	Mean	CL	*P-value*
Tail lesions pig level							
Number of pigs, n	*959*		*933*		*919*		
Pigs with tail lesions, %	5.0[a]	4.0-6.1	6.6[b]	5.3-8.2	1.4[c]	0.91-2.2	<0.001
Tail lesions pen level							
Number of pens, n	*47*		*47*		*47*		
Pens holding pigs with tail lesion,%	13.0[a]	8.2-19.9	34.3[b]	24.3-46.1	12.8[a]	7.3-21.6	<0.001

[a, b] Values within a row with different superscripts differ significantly at $P<0.05$.

Table 5 *Comparison of pigs moved to hospital pens (%), dead/euthanized pigs (%), antibiotic treatments (average per pen) and abattoir tail biting remarks (%) between docked and undocked pigs.*

	Undocked			Docked			
	n	Mean	CL	n	Mean	CL	*P*-value
Pigs moved to hospital pens, %	47[1]	3.87	1.99- 5.75	48	1.53	0.57- 2.48	0.03
Dead/ euthanized pigs, %	12[2]	2.93	1.21- 4.64	12	3.67	2.32- 5.01	N.S (0.64)
Started antibiotic treatments, n	47[1]	34.1	29.3- 39.0	48	26.5	22.2- 30.8	0.02
Abattoir tail biting remarks,%	853[3]	2.00	-	933	0.32	-	<0.001[4]

[1] Pigs moved to hospital pens and started antibiotic treatments were analysed on pen level (n=47)

[2] Dead/euthanized pigs were analysed on batch level (n=12)

[3] Number of slaughtered pigs

[4] Chi-Square = 11.24

Figure captions

Figure 1 Experimental pen design.

Figure 1

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