The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK
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Prevalence and severity of tail lesions as a possible welfare indicator for rabbit does

J Bill*, SL Rauterberg*, J Stracke, N Kemper and M Fels

Institute for Animal Hygiene, Animal Welfare and Farm Animal Behaviour, University of Veterinary Medicine Hannover, Foundation, Bischofsholer Damm 15 (Building 116), D-30173 Hannover, Germany
* Contact for correspondence: joana.bill@tiho-hannover.de/sally.rauterberg@tiho-hannover.de

Abstract

*The impact of behavioural disorders on animal welfare in modern animal husbandry has been much debated. While other abnormal behaviours have been explored at length, there are a paucity of studies on tail-biting in rabbits (*Oryctolagus cuniculus*). In the present study, severe tail lesions were observed in group-reared rabbit does on a commercial rabbit farm. In the subsequent investigations, the occurrence of tail lesions in 219 rabbit does from nine batches was compared between group- or single-housing and a scoring system recording the severity of tail lesions was developed and verified. This five-grade scoring system was applied to evaluate the progression of prevalence and severity of tail lesions in 21 groups during rearing in two batches. The results revealed a significant difference in the score level between housing types with a higher prevalence of injured tails in group- (60.4%) compared to single-reared (4.0%) does. An increase in severity and frequency of tail lesions was observed in groups during the course of a rearing period. Furthermore, the established scoring system was characterised by adequate observer reliability. Overall, tail injuries occurred on a regular basis in the investigated rearing groups, indicating tail-biting to be a prevalent problem. This could be considered relevant in terms of animal welfare, both for the animal doing the biting and the individual being bitten. The findings draw attention to an inadequately described problem in rabbit husbandry. However, the search for preventive measures needs to scrutinise the role of single-housing, without failing to consider the gregarious nature of rabbits.*

Keywords: *animal welfare, behavioural disorder, group-housing, rabbits, scoring system, tail-biting*

Introduction

Abnormal and stereotyped behaviours are frequently examined in farm and/or laboratory animals. Abnormal and stereotyped behaviours are often associated with an inappropriate environment, frustration and stress and are therefore frequently used as indicators of animal welfare (Dantzer 1986; Mason 1991; Stauffacher 1992; Morton *et al* 1993; Jordan *et al* 2006; Trocino & Xiccato 2006; Verga *et al* 2007). In rabbits (*Oryctolagus cuniculus*), disorders such as trichophagia (Brummer 1975; Gunn & Morton 1995; Lebas *et al* 1997; Graf 2010), wire gnawing (Hansen & Berthelsen 2000; Verga *et al* 2004; Princz *et al* 2007; Trocino *et al* 2014; Bozicovich *et al* 2016), cage pawing or digging (Podberscek *et al* 1991; Stauffacher 1992; Gunn & Morton 1995; Lidfors 1997), automutilation (Brummer 1986; Iglauer *et al* 1995) and ear biting (Maertens & De Groote 1984) have been described. Although tail-biting has been reported in group-housed breeding does (Baumann *et al* 2003) and broiler rabbits (Kalle 1994), it is yet to be characterised in detail, as regards severity, prevalence or aetiology. This is in direct contrast to pigs where tail-biting has been studied extensively (EFSA 2007). This has a variable prevalence and is influenced by a multitude of individual and environmental factors, such as a high stocking density, health parameters or a lack of enrichment for oral manipulation (Moinard *et al* 2003). In pigs, tail-biting is a broad term, encompassing gentle oral manipulation of the tail, biting that inflicts skin wounds, amputates portions of the tail and even gouging the rump. Tail-biting has considerable animal welfare implications, not to mention economic consequences, for pig production. Scoring of tail lesions is a widely used evaluation tool for quantifying tail-biting on pig farms (Taylor *et al* 2010).

In order to gain more information about tail-biting and its consequences in rabbits, the aim of the present study was to first collect comparative data about the frequency of tail lesions in group- and single-reared rabbit does. The second step entailed the development and verification of a scoring system, clearly describing the severity of tail lesions and enabling incidence evaluation during the course of a rearing period.

Figure 1

Score 0	Score 1	Score 2	Score 3	Score 4
Healthy	Hair damage	Small lesions	Large lesions	Loss of tissue
Skin and tail hair are intact. Totally healed skin lesions (scars) are counted as healthy	An obvious partial or total loss of fur or broken and torn off hair	Skin lesions that stretch up to 25% of the total skin surface, no matter how old or profound lesions are	Skin lesions that stretch to more than 25% of the total skin surface, no matter how old or profound lesions are	Partial or total loss of tissue such as necrotic loss of the tail tip and exposed bone parts

Scoring system classifying tail lesions into five levels of severity.

Materials and methods

Data were collected at a commercial rabbitry in Germany keeping approximately 600 breeding does and their offspring for fattening. Handling the rabbits for the purposes wound scoring was approved by the Animal Welfare Office of the University of Veterinary Medicine Hannover, Foundation, Germany.

Study animals and husbandry

Data were collected on future breeding does (Hyplus PS 19, Hypharm SAS, France), that had been purchased aged three to five days, suckled by foster mothers and weaned at 30 days of age. Animals were then housed in groups until 84 days of age during the growing period and then transferred to wire mesh cages where they were housed either singly or in groups of four to five animals per cage. Cages measured approximately 50 × 40 × 50 cm (length × width × height) for single-housing and approximately 100 × 50 × 37 cm for group-housing. Stocking densities were determined by the routine practice of the farm. Buildings were force-ventilated with manual control and artificially lit. Manure was collected in pits. In every cage, a pelleted diet (Viko Fok Prim, Victoria Mengvoeders, The Netherlands) mixed with chopped hay was offered *ad libitum* and water was freely available from one nipple drinker per cage.

Initial data collection

In the initial study, two observers obtained data on tail lesions of 219 young rabbit does from nine rearing batches at 23 weeks of age prior to the does being moved to their breeding cages. One hundred and forty-four of these does had been group-housed and 75 animals singly housed. During this procedure, the whole tail was palpated thoroughly to detect all lesions including small ones covered by fur. Three types of conditions were distinguished: tail without lesions; tail with lesions; and the partial loss of the tail. Photographs were taken both of intact and injured tails.

Development of a scoring system for tail-biting

Four independent observers were then asked to cluster 37 pictures of a wide range of tail conditions into five groups according to severity. Based on these clusters and the underlying thresholds, a five-level scoring system was created (Figure 1). After developing the scoring system, the agreement between two different observers was measured in practice. Both observers scored the tails of fifty-seven 161 day old does independently of each other to evaluate inter-observer reliability.

Implementation of the scoring system during the rearing period

To validate the scoring system and examine the progression of tail lesions during rearing, 91 does in two batches were separated into groups of four (batch 1: $n_4 = 7$ groups; batch 2: $n_4 = 7$ groups) or five (batch 1: $n_5 = 1$ group; batch 2: $n_5 = 6$ groups). Does were checked for tail lesions five times every two weeks by removing them from their cages and carefully inspecting their tails as previously described. Examinations started three weeks after the does had been put into groups, at the age of 105 days, and ended at 161 days, one week before the first parturition.

Statistical analysis

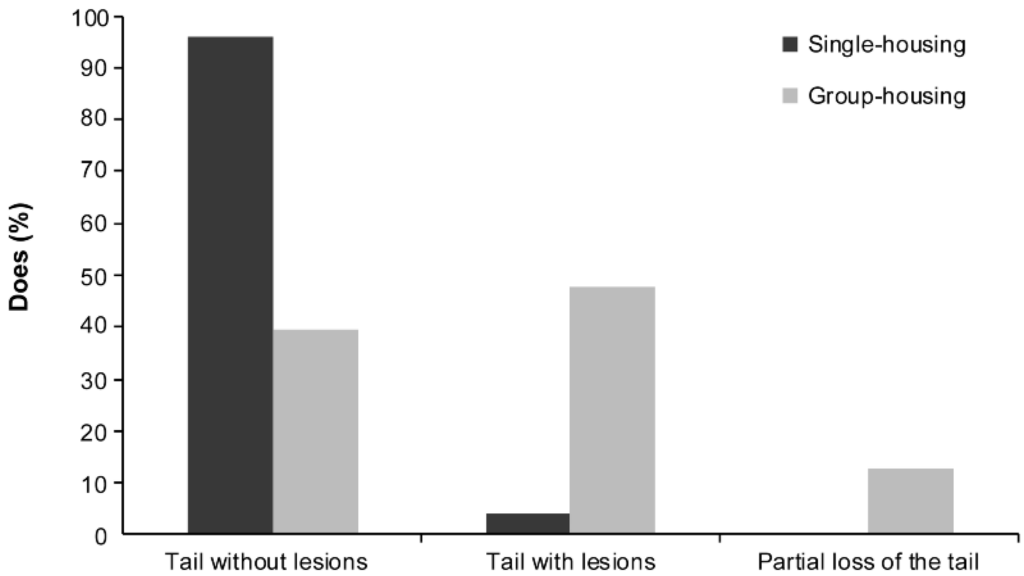
All data were analysed using SAS Version 9.4 (SAS Institute Inc, Cary, NC, USA).

Tail lesion scores in the initial data collection were analysed using a generalised linear model (PROC GENMOD). Housing type (group/single) and rearing batch (1–9) were included as fixed factors. The DIST option and LINK function were set to DIST = multinomial and LINK = cumlogit as proposed for ordinal data. The level of significance was set at $P < 0.05$.

Inter-observer reliability for the scoring system was calculated using Krippendorff's alpha with the macro (KALPHA) provided by Hayes and Krippendorff (2007). The level of measurement was set to 2, representing ordinal data. Krippendorff (2004) required $\alpha \geq 0.8$ for good agreement.

For analysing the data (scores of tail lesions) in the rearing period, once again the GENMOD procedure was applied, using DIST = multinomial and LINK = cumlogit. Group size (4/5), age at data acquisition (105–161 days) and their

Figure 2



Percentage of rabbit does ($n_{group\text{-}housing}$ = 144; $n_{single\text{-}housing}$ = 75) with different degrees of tail lesions from single- or group-housing. The generalised linear model revealed a significant effect of housing on tail condition (Chi-squared = 14.32; df = 1; $P < 0.001$).

interaction were included as fixed factors. Repeated measurements on the individuals were taken into account when nesting the individual in the respective group. Unlike other logistic models, the GENMOD procedure does not provide odds ratios as a standard. We therefore implemented the ESTIMATE statement (testing specified hypothesis concerning the model parameters) in combination with the EXP option (which produces odds ratios when the response variable is binomial or multinomial, the link function therefore including a logit function). The level of significance was set at $P < 0.05$.

Results

Initial data collection

Housing showed a significant effect on the occurrence of tail injuries with more injuries in group-housed rabbit does compared to single-housed ones (Chi-squared = 14.32; df = 1; $P < 0.001$; Figure 2). In the initial data collection only 39.6% of animals from group-housing had intact skin on their tails, whereas singly housed does were mainly uninjured (96.0%). Tail lesions occurred in 47.9% of group-housed and 4.0% of singly housed does. Loss of tissue was observed in 12.5% of group-housed does but was not detected in singly housed animals. Group-housed rabbits with a loss of tissue were observed in six out of nine batches and group-housed rabbits with skin lesions were found in every batch. A significant effect of the batch was also found (Chi-squared = 23.72; df = 8; $P < 0.01$).

Development of a scoring system for tail-biting

A detailed description of the five-scale scoring system developed can be found in Figure 1. Krippendorff's Alpha Reliability Estimate for this score was 0.95.

Table 1 Detailed results of comparison between ages.

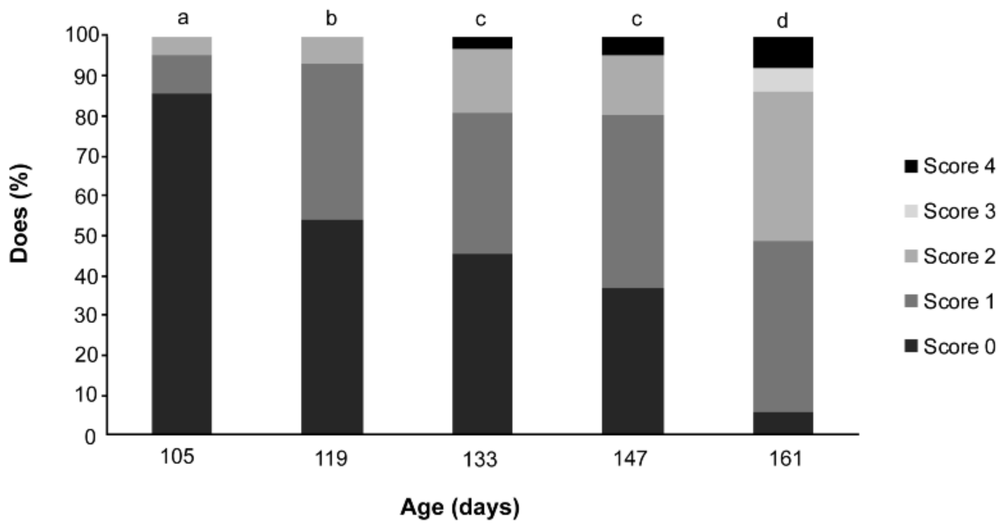
Compared ages (days)	Mean estimate (± SEM)	95% CI	ChiSq	*P*-value
105 vs 119	0.75 (± 0.36)	0.60–0.86	9.44	0.002
105 vs 133	0.84 (± 0.34)	0.73–0.91	23.46	< 0.001
105 vs 147	0.88 (± 0.36)	0.78–0.93	29.58	< 0.001
105 vs 161	0.97 (± 0.37)	0.95–0.99	95.96	< 0.001
119 vs 133	0.64 (± 0.26)	0.52–0.74	4.93	0.026
119 vs 147	0.70 (± 0.25)	0.59–0.79	11.53	< 0.001
119 vs 161	0.92 (± 0.33)	0.86–0.96	57.41	< 0.001
133 vs 147	0.57 (± 0.22)	0.46–0.67	1.67	ns
133 vs 161	0.87 (± 0.27)	0.80–0.92	50.59	< 0.001
147 vs 161	0.84 (± 0.24)	0.76–0.89	47.67	< 0.001

ChiSq: Chi-square estimation.

Implementation of the scoring system during the rearing period

During the rearing period, three does from batch one and one from batch two died during data collection. In batch two, data from 24 does were missing for the first examination day due to reasons of practicality. Finally, n = 416 observations of n = 90 animals were used for analysis. The age at data acquisition revealed a significant effect on tail lesion with increasing score levels throughout the rearing period (Chi-squared = 56.32; df = 4; $P < 0.001$). Hair damage and smaller lesions were found right from the start of observations, whereas a loss of tissue first occurred at

Figure 3



Distribution of tail lesion scores in group-housed does (n = 90) starting from the age of 105 days until the end of the rearing period at the age of 161 days. Different superscripts indicate significant differences in the scoring level of tail lesions (P < 0.05).

133 days of age. At day 161, 94.2% of tails were affected by tail lesions or damaged hair (Figure 3). Odds ratios, indicating the relative difference between the different ages at data acquisition, revealed that younger ages scored significantly better than older (all $P < 0.05$; see Table 1 for detailed information), although this was not the case for the comparison between 133 and 147 days (95% CI 0.46 to 0.67; $P > 0.05$) (Figure 3). Group size and the interaction between group size and age revealed no significant effect (group size: Chi-squared = 0.05; df = 1; $P = 0.82$; group size × age: Chi-squared = 2.77; df = 4; $P = 0.60$).

Discussion

Behavioural disorders which occur commonly in farm animals are often discussed in terms of causes and solutions. However, the first step towards reducing behavioural disorders and thereby improving animal welfare is to recognise and describe them. The data collected revealed tail injuries in rabbits to occur regularly on this particular commercial farm and with varying degrees of severity. The significantly higher percentage of tail lesions in group-raised rabbits is strongly indicative of reciprocal manipulation of the tail. Furthermore, trichophagia from the tail region and tail-biting were observed in other groups on the same farm. Nevertheless, as a result of a lack of empirical data, tail-biting as defined as a self-directed abnormal behaviour, ie as has been described in mink (Mason 1994; Vinke *et al* 2002), cannot be completely excluded, particularly since automutilation has already been described for rabbits in another context (Brummer 1986; Iglauer *et al* 1995). Technopathies, caused by the rabbits' environment are also possible although unlikely, as a differential diagnosis, since wire mesh and cage elements as well as feeders were comparable for both single- and group-housing. It is also possible that fur on tail tips could become caught on the wire wall mesh of cages and consequently broken or torn off, when rabbits fought in the very confined space, thereby simulating the occurrence of trichophagia. However, wisps of fur, entangled in mesh bars, were never found, therefore trichophagia seems more likely. Nevertheless, rabbits' interactive behaviour make injuries caused by cage equipment more likely in group-housed animals.

Animal behaviour and abnormal behaviours, such as tail-biting, are often influenced by housing and management (Morton *et al* 1993; Jordan *et al* 2006; Trocino & Xiccato 2006; Verga *et al* 2007), so these factors should be considered and discussed in terms of aetiology and potential for improvement. In terms of Europe, rabbit farming for meat production is more common in central and, especially, southern Europe, whilst in the north, rabbits are kept mostly as companion animals (DG Health and Food Safety 2017). The rabbit has highly adapted social behaviour in the wild and, as such, both farmed and companion rabbits should be kept in groups; laboratory rabbits should also be group-housed unless specifically recommended for scientific or ethical reasons. However, in the UK, 58.1% of the rabbits kept as pets were housed without a conspecific (Rooney *et al* 2014). In farmed rabbits, group-housing might be possible for breeding does during non-lactation and for young does prior to mating (Trocino & Xiccato 2006). Nonetheless, after their growing period, future breeding rabbits in Europe are typically kept in single cages and far less frequently in pairs (EFSA 2005). Even if individual housing does not comply with rabbits' social needs, it is usually implemented in breeding rabbits because of the likelihood of aggression developing between animals and resultant injuries (Drescher 2002; Szendrő & McNitt 2012). While breeding does and broiler rabbits are often the focus of research, little data are available for the rearing period of females, even if this period might be of relevance for the does' future health and productivity (Rommers *et al* 1999).

In non-breeding young females, Chu *et al* (2004) found a significantly greater amount of abnormal behaviour in singly compared to pair-housed animals. The latter spent 26.7% of the recorded time in direct physical contact and were more active than singly housed animals. In laboratory rabbits, housing with a conspecific is also recommended to allow animals more opportunity to exhibit species-specific behaviours (Baumans & Van Loo 2013). Similarly, different stereotypical behaviours were only observed in individually caged rabbits and not in group-housed rabbits (Podberscek *et al* 1991; Gunn & Morton 1995; Held *et al* 2001; Chu *et al* 2004). For gregarious animals, a social partner represents an enrichment factor as it provides the possibility for interactive behaviour (Baumans 2005). However, both the quality and quantity of social interaction depends on the social and spatial environment as well as experiences during early development. Animals must be compatible and group composition should remain stable (Stauffacher 1992; Morton *et al* 1993; Baumans 2005). Group-housing is recommended because it allows rabbits to express species-specific behaviours that involve social partners. Furthermore, the relative space availability for each individual is increased and the overall size increase allows for functional subdivision of the pen (Held *et al* 2001). Offering larger cages to rearing does leads to an increase in activity and a reduction in time spent lying (Bignon *et al* 2012). Taking all these findings into account, leads to the conclusion that group-housing is the optimum housing condition for rearing future breeding rabbits.

However, this study also found group-housed animals to be at greater risk of tail lesions. As with most commercial rabbit farms, the cages were characterised by restricted space allowance and a lack of structure and enrichment (DG Health and Food Safety 2017). Although this confers practical advantages, such as uncluttered functionality and better hygiene, it may lead to restricted movement and no division into functional areas. Moreover, appropriate environmental stimuli are not provided which are crucial to the expression of normal behaviours (Dantzer 1986; Lehmann 1987; Stauffacher 1992). Therefore, this inadequate environment combined with group-housing may lead to negative effects, such as the development of abnormal behaviours, as were demonstrated here. Structural elements, such as visual barriers or places for escaping and hiding, could be potentially used for resting-comfort and to minimise aggression (Lehmann 1987; Baumans 2005), and may prevent behaviours like tail-biting. Kalle (1994) associated tail-biting with small and unstructered cages but no data were published in support of this and tail-biting has also been reported in lactating does kept in a structured and littered housing system (Baumann *et al* 2003). Nevertheless, an adjustment in housing conditions may positively affect tail-biting behaviour and its consequences. This could be one reason why the problem is not widespread in pet rabbits, where animals tend to spend the majority of their lives in enriched housing with some degree of shelter (Rooney *et al* 2014). Still, the current state of research into tail-biting in rabbits allows for only speculation on trigger factors and the motivation of the active, biting rabbit. Furthermore, it should also be considered that hair-eating from the tail region and tail-biting might both be based on different stimuli.

The wild rabbit spends approximately one- to two-thirds of its active time grazing (Mykytowycz & Rowley 1958), while fattening rabbits in intensive housing, fed with a pelleted diet, spend only about 10–15% of their time feeding (Morisse & Maurice 1997). The discrepancy between feed intake in caged, pellet-fed rabbits and normal grazing behaviour combined with the fact that rabbits can neither gnaw nor occupy long periods of time with food intake, leads to the assumption that wire gnawing is caused by lack of opportunities for normal foraging activity (Stauffacher 1992). Thus, the time not spent in exploring, manipulating and taking food might lead to an unsatisfied need for oral activity and may also motivate the rabbits to bite each other's tails. In social housing, an unbalanced diet with a lack of fibre and unsatisfied feed intake behaviour can also lead to trichophagia (Brummer 1975; Lebas *et al* 1997) which, in the tail region, might accidentally result in biting into the tail tip.

Besides foraging behaviour, excessive social grooming might contribute to this abnormal behaviour. If grooming becomes too intense, it can cause hair loss and inflammation; this is also referred to as overgrooming (Bradbury 2016). Access to straw bedding reduces social grooming in group-housed fatteners as well as self-grooming behaviour in single kept does (Metz 1987). Singly housed rabbits, which were fed hay, performed less excessive self-grooming (Berthelsen & Hansen 1999). This evidence suggests a link between foraging behaviour and grooming and, therefore, foraging behaviour and grooming cannot be considered as completely separate issues. Intensive grooming and oral manipulation can result in pulling and even eating of the individual's own hair (Gunn & Morton 1995) or the hair of the social partner (Brummer 1975). In the most severe cases, this might lead to wounds or a loss of tissue. Nonetheless, tail-biting as an expression of overgrooming seems unlikely, since rabbits focus typically on the area of the head when performing allogrooming (Bradbury 2016). Nevertheless, as enrichment for oral manipulation could be observed to reduce abnormal behaviours such as bar gnawing (Lidfors 1997; Jordan *et al* 2003; Luzi *et al* 2003; Verga *et al* 2004; Princz *et al* 2007; Siloto *et al* 2008), it may also reduce fur eating or even tail-biting in rabbits, as it is a common approach in pigs (Taylor *et al* 2010).

This study is a first approach at better describing tail-biting and its effects using the prevalence and severity of tail lesions as indicators. This method shows one limitation, however, as it only registers the receivers and not the perpetrators and fails to include direct observations of the inducing behaviour. Still, it is an easy method, suitable for on-farm implementation which allows quantification of the phenomenon of tail-biting in rabbit stocks. Using a scoring system to evaluate the intensity of tail-biting is an accepted tool in pigs (Taylor *et al* 2010) and the interobserver-reliability for the five-grade scoring system used in this study displayed good repeatability. Recording the percentage of injured skin as opposed to the absolute wound size has the advantage of making the scoring system applicable for all breeds in all age groups instead of limiting it to one uniform population of rabbits. Complicated scoring systems with many degrees of severity tend to decrease interobserver reliability (Webster *et al* 2008) and can be time-consuming. To keep the scoring system simple (and thus reliable), further classification of wound sizes was considered not to be constructive. In most cases, smaller wounds directly merged into a loss of tissue without large wounds as an intermediate condition. Evaluating other parameters, for example, wound depth and signs of inflammation using histopathological methods might enable a more detailed insight into the underlying problem.

The application of the scoring system showed an increase in tail lesion frequency and severity during the rearing period in both batches. As breeding does are usually separated for parturition, this effect might be even more pronounced in rabbits not kept for reproductive purposes and thereby remaining in groups. It is likely that the condition of the tails would deteriorate over a prolonged period of group-housing. Within a rearing period, the does grow and reach sexual maturity. Both facts could provoke agonistic behaviour because space availability is reduced, thereby increasing stocking density, leading to possible increased aggression between females (Myers & Poole 1961). Furthermore, the natural competitive struggle becomes more intense with age and maturity (Nevalainen *et al* 2007; Olivas & Villagrá 2012). Tail-biting could therefore be an aggression-motivated behaviour, performed by the dominant animal towards subordinates, with unstructured cages offering nowhere to hide.

More research is required to detect the impact of housing conditions, such as enclosure size and structure, stocking density or access to litter material as well as nutritional factors, such as the amount of crude fibre in the diet. Since no detailed description exists of the aetiology of tail-biting in rabbits, a clear classification into abnormal, aggressive or otherwise motivated behaviour is not yet possible. As a result, direct observation of the behaviour might provide more clarity. Researchers would then have to overcome the difficulty of the observer effect or rely on video recordings, with the problem of distinguishing between trichophagia and tail-biting.

As with pigs, it can be assumed that for rabbits tail-biting resulting in injuries, reduces welfare both of the bitten animal as well as the biter, since the latter is demonstrating this behaviour as a consequence of a frustrating and unsatisfactory environment (Schrøder-Petersen & Simonsen 2001). Thus, the occurrence of tail-biting and associated injuries should, in any case, be prevented. Further investigations should be undertaken to gain more information on its severity, aetiology and prevalence in other herds.

Animal welfare implications

The intention of this study was to highlight a specific behaviour in rabbits which can create major problems for animal welfare. It can be assumed that tail-biting resulting in severe lesions and, in particular, loss of tissue, will be highly painful and, as such, should be prevented wherever possible. Contact with conspecifics is crucial to a gregarious species such as the rabbit (Drescher 2002) and the welfare of singly housed rabbits would appear compromised as they display more stereotypical behaviours than group-housed rabbits (Podberscek *et al* 1991; Gunn & Morton 1995; Held *et al* 2001; Chu *et al* 2004). Therefore, single-housing is not an ideal alternative to prevent tail-biting. A social partner provides diversified enrichment (Baumans 2005) and allows the animal to indulge more of its species-specific behavioural repertoire. Therefore, efforts should be made to develop housing and management conditions, which succeed in rearing rabbits in groups without the occurrence of tail-biting behaviour.

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