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Data paper

Social interactions, precursors of damaging behaviours, object manipulation, straw rooting, and activity: a detailed data set in undocked pigs under protein restriction

L. Roch [a,b], E.O. Ewaoluwagbemiga [b,c], C. Kasper [b,*]

[a] Animal Welfare Division, Veterinary Public Health Institute, University of Bern, Länggassstrasse 120, 3012 Bern, Switzerland
[b] Animal GenoPhenomics, Agroscope, Tioleyre 4, 1725 Posieux, Switzerland
[c] Department of Environmental System Science, Animal Genomics, ETH, Universitätsstrasse 2, 8092 Zürich, Switzerland

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ABSTRACT

Damaging behaviours, such as tail biting, are common problems in pig production, compromising animal welfare and causing economic losses. Detailed studies are impeded by laborious direct observations. Tail biting is a broader phenomenon that begins long before lesions manifest, and behavioural problems caused by various stressors present themselves weeks before they escalate to damaging behaviour. Therefore, we collected detailed data on behaviours considered precursors to tail biting, such as oral and nasal manipulation of conspecifics. Dietary protein reduction is a promising way to reduce nitrogen emissions in pig manure, but its implications for animal welfare are not yet clear. The CP content in the diet was reduced to 80% of the recommendations. Pigs differ in their ability to utilise dietary proteins; therefore, there might be individual differences in how they cope with the protein reduction. Here, we present detailed data of focal observations of 95 pigs at an experimental farm with undocked tails. Pigs were observed directly by the same person for five minutes on four different days. All actions directed towards objects in the pen, interactions with and confrontations among pen mates, straw rooting behaviour and general activity were recorded. After the behavioural observations, wounds on different body parts and the cleanliness were noted by the same person observing the pigs. The protein efficiency of 94 pigs was obtained. The data set comprises six tables. The first table contains information on the animals, including the identities of their parents, farrowing group, sex, and protein efficiency. The other data tables contain four 5-min observations of each pig on 10 object-manipulation behaviours; 150 interaction behaviours, including reactions; 14 confrontation behaviours and their outcomes and reactions; 10 mounting behaviours, including reactions; two rooting behaviours; seven basic behaviours; and an index of general activity. The observations took place under comparatively good housing conditions. Pigs were given fresh straw daily, *ad libitum* access to feed, floor space above the legal requirements, and daily cleaning of pens, and they were closely monitored for signs of damaging behaviour; all of these are favourable conditions as they limit stress and the risk of damaging behaviour. These data can be used to further explore the relationships of specific behaviours and phenomena and their association with protein efficiency. The ethogram can be used as a template for further observations. Practitioners could use the data to support pigs' need for occupation, such as by providing sufficient straw.

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* Corresponding author.
E-mail address: claudia.kasper@agroscope.admin.ch (C. Kasper).

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Specification table

Subject	Welfare, Behaviour and Health Management
Type of data	Tables
How data were acquired	Five-minute real-time behavioural observations on four occasions of Swiss Large White pigs (LBO:0000378) and grading of their lesions in their home pen between days 98 and 115 after birth. All these data were recorded by the same person (LR). Feed intake was monitored with automated feeder stations (Schauer Maschinenfabriken GmbH & Co KG, Prambachkirchen, Austria). The lean mass of pig carcasses to estimate protein efficiency was determined using dual-energy X-ray absorptiometry (GE Lunar i-DXA, GE Healthcare Switzerland, Glattbrugg, Switzerland). The scans were all done by one person (EOE).
Data format	Raw data
Parameters for data collection	Data were collected at an experimental farm during daylight between 1245 and 1600. Up to 24 pigs were kept in a 36.78 m^2 pen, with 24.78 m^2 of concrete floor and 12 m^2 of slatted floor. Pigs were not tail-docked and received protein-reduced grower and finisher diets. Behavioural data were collected using an ethogram developed before the start of the behavioural observations. Wounds, cleanliness, and tail posture were recorded subsequently in artificial light.
Description of data collection	The behaviour of pigs from two farrowing series was recorded in August and December 2020 using focal sampling by direct observation (the observation order was randomised). Each pig was individually marked with a livestock marking spray (Fig. 1).The observer was outside the pen to limit the influence on the animals as much as possible and started observing after a 15-min acclimation time. The behaviours of the observed pig (performed and received by the focal pig), as well as the wounds, tail position, and cleanliness of each pig, were recorded on a paper form. The classification of lesions, tail position, and cleanliness were based on the literature. The pigs' protein efficiency was recorded the day after slaughter and was thus only known to the observer after the observations.
Data source location	Institution: Agroscope (https://www.agroscope.admin.ch/agroscope/en/home.html) City/Town/Region: Posieux, Fribourg Country: Switzerland Latitude and longitude for collected data: 46.76891939265413, 7.104823352657323
Data accessibility	Repository name: Zenodo Data identification number: https://zenodo.org/record/7933011
Related research article	Roch, L., Ewaoluwagbemiga, E.O., & Kasper, C. (2023). Protein efficiency and pig welfare: no trade-offs for mitigating nitrogen pollution. bioRxiv. https://doi.org/10.1101/2023.03.03.530955

Value of the data

- The data comprise detailed direct behavioural observations of 95 pigs at 98–115 days of age. None of the pigs was subjected to tail-docking. Pigs were reared under generally favourable non-commercial management conditions. Their diet contained 20% less CP than recommended.
- Direct observations provided the opportunity to record victims of not only damaging behaviours but also more subtle behaviours, which could be precursors of tail biting, as well as interactions, confrontations, reactions, straw rooting, and general activity.
- The various behaviours and their reactions are defined in detail, by body part and by intensity. This can be used to further explore which behaviours are most predictive of damaging behaviours.
- Researchers in animal welfare and nutrition could use the data to test specific hypotheses.
- The data could be used as a basis for designing experiments, for instance, to compare behaviours during the different stages of development and thus analyse a potential pattern of development of damaging behaviours.
- The data could help practitioners to develop software in combination with surveillance cameras that automatically recognises problematic and damaging behaviours and could facilitate observation and prevention of lesions.
- The data could help to support research on pigs' non-negligible needs, such as the possibility to root and explore.
- The ethogram we developed for the data presented here was based on observations of pigs in comparably good housing conditions. It contains the majority of the behaviours observed under these conditions and can be used, for example, for further research on potentially deleterious behaviours.

Data description

The data comprise seven data sets and one table with the ethogram (Table 1). The common variable in all data sets is the pig's individual ID (pseudonymised ID from the Swiss national animal database).

Table 1
Line marking of pigs for the main study. The first column represents the number assigned to each pig in the group. The second column represents the line drawn at shoulder height and the third column represents the line drawn at flank height.

Number	Line at shoulder height	Line at flank height
1		I
2		II
3		III
4		IIII
5		/
6		/I
7		/II
8		/III
9		/IIII
10	I	
11	I	I
12	I	II
13	I	III
14	I	IIII
15	I	/
16	I	/I
17	I	/II
18	I	/III
19	I	/IIII
20	\	
21	\	I
22	\	II
23	\	III
24	\	IIII

1. **Table 1:** Ethogram with detailed descriptions of the single behaviours and their targets, based on observations prior to data collection and the literature.
2. **Animal:** 95 rows (one for each pig) and six columns; contains general information on the pigs.

- **pigID:** pseudonymised individual pig ID (four numbers followed by a dash and a 3-digit code)
- **fatherID:** pseudonymised paternal ID (four numbers followed by a dash and a 3-digit code)
- **motherID:** pseudonymised maternal ID (four numbers followed by a dash and a 3-digit code)
- **Group:** farrowing group (1 or 2)
- **Sex:** female or castrated male (F or M)
- **PE (ATOL_0002288):** protein efficiency (proportion between 0 and 1). One pig (ID: 7023-PO4) died before slaughter; hence, its protein efficiency could not be determined (*NA*).
- **Weight_1 (ATOL_0000351):** live BW during observations 1 and 2
- **Weight_2 (ATOL_0000351):** live BW during observations 3 and 4

3. **Objects:** 380 rows (one for each pig and each of the four observations) and 12 columns. Contains data on oral and nasal behaviours (biting **[ATOL_0005743]**, seizing, manipulating **[ATOL_0000845]**) towards objects such as metal chains **(EOL_0001925)**, pen borders (panels, walls, and bars **[EOL_0001543]**) and drinkers (**EOL_0001653;** valves or bowls dispensing water). Variables are composed as *object_action_unit.*

- **pigID:** pseudonymised individual pig ID (four numbers followed by a dash and a 3-digit code)
- **Observation:** observation number (1–4)
- **chain_bite_nb:** counts of bites on chain (integer)
- **chain_bite_sec:** time spent biting the chain (sec)
- **chain_seize_nb:** counts of seizing the chain (integer)
- **chain_manipulate_nb:** counts of manipulations of chain (integer)
- **border_bite_nb:** counts of bites on pen border (integer)
- **border_seize_nb:** counts of seizing the pen border (integer)
- **border_manipulate_nb:** counts of manipulations of pen border (integer)
- **drinker_bite_nb:** counts of bites on drinker (integer)
- **drinker_seize_nb:** counts of seizing the drinker (integer)
- **drinker_manipulate_nb:** counts of manipulations of drinker (integer)

4. **Conspecifics:** 380 rows (one for each pig and each of the four observations) and 152 columns. Contains data on oral and nasal behaviours (biting **[ATOL_0005743]**, seizing, manipulating **[ATOL_0000845]**) towards conspecifics differentiated according to body part, type of behaviour, and reaction. Variables are composed as *bodypart_action_active/passive_reaction_bodycontact.* Not all variables are listed here, only the different elements of the variables.

- **pigID:** pseudonymised individual pig ID (four numbers followed by a dash and a 3-digit code)
- **Observation:** observation number (1–4)
- *Body part:* head, tail, ears, perineal area (including the vulva and perineal region), and the rest of the body
- *Tail biting* **(ATOL_0000905)**
- *Action:* counts of biting **(ATOL_0005743)**, seizing, and manipulating (integer)
- *Active/passive:* The observed pig may be the actor of the action (active) or may be subjected to the action (passive). Passive_total is the sum of all other '_passive_' items. For instance, **head_bite_passive_total** is the sum of **head_bite_passive_cry, head_bite_passive_flee, head_bite_passive_snatch_active_nc, head_bite_passive_snatch_active_c, head_bite_passive_twitch**, and **head_bite_passive_noreaction**
- *Reaction:* snatch, cry **(ATOL_0005505)**, flee, twitch, no reaction (for description, see ethogram; Table 1)
- *Body contact* **(ATOL_0001564)***:* no physical contact (nc) or physical contact (c)

5. **Confrontations:** 380 rows (one for each pig and each of the four observations) and 26 columns. Contains data on confrontations and mounting behaviours. A confrontation is an agonistic situation that most often occurs when two pigs compete for a resource (e.g., the chain, feeder or drinker, passing each other, or taking the place of another).

- **pigID:** pseudonymised individual pig ID (four numbers followed by a dash and a 3-digit code)
- **Observation:** observation number (1–4)
- **Confrontation_active (ATOL_0005741)/passive (ATOL_0005745)/undetermined:** The observed pig may be the initiator of the confrontation (*active*) or the recipient (*passive*), or the initiation of the confrontation might not be attributable to a particular pig (*undetermined*).
- **Confrontation_dominant (ATOL_0000907)/subordinate (ATOL_0000908)/tie:** Three outcomes of a confrontation are possible. First, the observed pig obtains the resource at the expense of the other (e.g., keeps its place or takes the place of the other conspecific) (*dominant*). Second, the observed pig loses the confrontation and gives in (e.g., leaves its place or runs away from the confrontation) (*subordinate*). Third, the confrontation ends in the same way for both pigs (e.g., each one goes its own way) (*tie*).
- Confrontation_*reaction*: snatch, cry **(ATOL_0005505)**, flee, twitch, no reaction (for description, see ethogram Table 1)
- *Mount* **(ATOL_0001716)**_*active/passive_reaction*: climbing/jumping with one or more legs on another pig. The observed pig may be the actor of the action (active) or may be subjected to the action (passive), and the reaction can be one of the following: snatch, cry **(ATOL_0005505)**, flee, twitch, or no reaction (see definition above)

6. **Rooting:** 380 rows (one for each pig and each of the four observations) and five columns. Contains data on straw rooting on the floor and in baskets. Straw: **EOL_0001925**

- **pigID:** pseudonymised individual pig ID (four numbers followed by a dash and a 3-digit code)
- **Observation:** observation number (1–4)
- **root_bin:** whether or not the focal pig performed straw rooting behaviour on the floor (never in 5 min = 0, ≥1 s in 5 min = 1)
- **root_sec:** time spent rooting on the floor (seconds)
- **root_basket_nb:** counts of straw rooting in baskets

7. **Activity:** 380 rows (one for each pig and each of the four observations) and nine columns. Contains data on feeding, drinking, urinating/defecating, standing, sitting, lying and an activity score.

- **pigID:** pseudonymised individual pig ID (alphanumeric 6-digit code)
- **Observation:** observation number (1–4)
- **Feed (ATOL_0000777):** number of times the pig went to the automated feeding station **(EOL_0001741)** (integer)
- **Drink (ATOL_0000770):** counts of drinking at the valve or bowl (integer)
- **Urinate (ATOL_0000802)_defecate (ATOL_0000492):** number of times the pig urinated or defecated (integer)
- **Stand (ATOL_0000835):** number of times the pig was standing or shifted to standing position (on all four legs; integer)
- **Sit (ATOL_0000836):** number of times the pig was sitting or shifted to sitting position (on the hind legs, front legs extended; integer)
- **Lie (ATOL_0000837):** number of times the pig was lying or shifted to lying position (integer)
- **Activity:** The total primary activity score was calculated as follows: for 'feed', 'drink', 'urinate/defecate', and 'lie', one point was allocated; for 'sit', two points; and for 'stand', three points. Each position (lying, sitting, standing) and each change of position was counted. Thus, at least four points were assigned to each pig over the four observations.

8. **Lesions:** 380 rows (one for each pig and each of the four observations) and 40 columns. Cleanliness, lesions of different severity and number on various parts of the body (tail integrity **[ATOL_0002146]**), and tail posture. Variables for lesions are composed as *bodypart_category_quantity.* Not all variables are listed here, only the different elements of the variables. Observations followed the score sheet in Table 3.

- **pigID:** pseudonymised individual pig ID (four numbers followed by a dash and a 3-digit code)
- **Observation:** observation number (1–4)
- **Cleanliness:** 1 (clean; <10% of body surface covered with faeces), 2 (slightly soiled; 10–30% of body surface covered with faeces), 3 (heavily soiled; >30% of body surface covered with excrement)
- *Body part:* head, ear, tail, perineal area (including the vulva and perineal region), body (rest of the body)
- *Skin lesion* **(ATOL_0005749)** *category:* 0 (no lesions at all), 1 (scratches), 2 (wounds), and 3 (missing part of tail or ear)
- *Quantity:* few (fewer than five lesions) and many (five or more lesions)
- **Tail posture (ATOL_0000839):** 1 (corkscrew), 2 (straight or drooping), 3 (between the legs)

Experimental design, materials and methods

Animals

The data on 95 Swiss Large White (Fig. 1) pigs from two farrowing series presented here were collected in the course of a larger experiment on the genetic basis of protein efficiency in pigs at Agroscope Posieux in Switzerland. The pigs, 53 females and 42 castrated males, were observed four times each between the ages of 98 and 115 days. In each farrowing series, pigs were housed in two groups of 23 or 24 pigs in pens with a surface are of 36.78 m^2 (24.78 m^2 of solid concrete area and 12 m^2 of slatted floor). An additional 2.62 m^2 contained four stations with an automatic feeder (Schauer Maschinenfabriken GmbH & Co KG, Prambachkirchen, Austria) each, two dispensing grower feed for 20–60 kg BW, and two dispensing finisher feed for over 60 kg BW. The automatic feeders were accessible to the pigs via an individual identification device (RFID tag in the ear). The concrete floor of each pen was covered with a thin layer of straw, and there were two mobile and two fixed straw baskets in each pen. Approximately 4 kg of unchopped straw was distributed per pen per day. Four drinking stations were available per stall, two single-tube valves and two bowls. As occupation material, four metal chains were suspended, three of them from the same ring. Two sides of the pen were walled, and the other two sides were boarded and barred. The two groups had only auditory and olfactory contact with each other. The pigs were regrouped twice: the first time after weaning at the age of approximately 6 weeks, when they were allocated to a starter pen with pigs from other litters to a maximum of 12 animals per automatic feeder. The second grouping occurred when the pigs reached an average weight of 23 kg (i.e., at 73 days of age ± 10 days [mean ± sd]), when the piglets were switched from starter feed to grower feed. Pigs that reached this weight in the same period were grouped together at a maximum number of 24 pigs per group. The pigs were fed *ad libitum* from 7:40 to 23:30 with an experimental diet produced at Agroscope containing 80% CP content compared with the current Swiss recommendations (Agroscope, 2016), with an equal reduction of all amino acids. The feed therefore contained 128 g/kg of CP for pigs from 20 to 60 kg (grower feed) and 112 g/kg for those from 60 kg (finisher feed).

Behavioural observations

Behavioural observations took place in daylight between 1245 and 1600 to minimise the influence on the pigs' daily routine and to observe them when they were naturally more active. Each Monday morning during weighing, each pig was individually marked with lines sprayed on the back, drawn from one side of the body across the back to the other, to be able to identify it from different sides (Fig. 1, Table 1). In this way, the observer could easily follow one pig through the five minutes of observation. On a particular day, one single pen was observed, and all the animals in that pen were observed one after another, in a randomly determined order. Each pig was observed on four different days over 2 weeks, 2 days per week, resulting in a total of 20 min of observation per pig. Pigs were observed using the focal sampling method (Martin and Bateson, 1993) in a randomised sequence. Before the observation, the observer (LR) walked calmly towards the group so that the animals would notice her without panicking. Observations began after a 15-min habituation period, during which the behaviours of the focal pigs were recorded on a paper form following the ethogram, which was developed prior to this study (Table 2). During the observations, the observer stood on a high ladder outside the pen to limit her influence on the animals as much as possible. In addition, reactions or the lack thereof to observed behaviours between conspecifics were recorded. It should be noted that 'snatching' could also occur as a reaction to a behaviour received during a confrontation. The total primary activity score was calculated as indicated in Data Description point 7, on a biological basis. A standing body was considered more physically active than a body lying down. A change in position

Fig. 1. Example of the individual marking of a pig using spray, which was renewed each week. The marking was traced from one side of the body over the back to the other to enable its recognition from different sides.

Table 2
Ethogram of observed pig behaviours.

Category of behaviour	Description of behaviour	Target of behaviour
Oral and nasal actions		
Biting	Opens and closes jaw with force at least once, and uses teeth	Objects, pen mates
Seizing	Opens and closes the jaw without force at least once, not using teeth	Objects, pen mates
Manipulating	Keeps the jaw closed, manipulates with the snout, the snout is mobile. The jaw may be relaxed and mobile but the individual does not grasp with the mouth	Objects, pen mates
Reactions		
Snatch	Sharp movement of the head towards the conspecific with the mouth open for the purpose of biting in reaction to a behaviour (with or without body contact)	Pen mates
Cry	Makes an audible noise	Pen mates
Flee	Escapes by moving away (locomotion)	Pen mates
Twitch	Subtle behaviours such as moving a part of the body, e.g., the head or a paw, standing up, sitting or lying down, turning away the head, or weak head-butting	Pen mates
Rooting	Manipulates the straw on the ground or in a basket with the snout, often bites into the straw or eats the straw	Straw on the ground or in a basket
Confrontations between pen mates	Pen mates physically oppose each other with face-to-face or head-to-body contact, with a push that can be gentle to strong	Pen mates
Feeding	Feeds at one of the automatic feeders	
Drinking	Drinks from one of the water bowls or valves	
Urinating/defecating	Discharges urine or faeces	
Standing	The body is supported by the four straightened legs	
Sitting	The front of the body is supported by the two straightened forelegs, the rear rests on the ground	
Lying	The whole body rests on the ground	

Table 3
Observations of lesions, tail posture and cleanliness of the pigs.

Observation	Categories
Lesions[1]	0: no lesion 1: superficial lesions (scratches) 2: wounds (deep lesions, clearly visible fresh or dried blood) 3: part of tail or ear missing
Quantity of lesions	few: no lesions or fewer than five many: five or more lesions
Tail posture[2]	1: corkscrew 2: tail straight or hanging 3: tail tucked between legs
Cleanliness[3]	1: clean (less than 10% of the body surface covered in excrements) 2: slightly soiled (10–30% of the body surface covered in excrements) 3: heavily soiled (more than 30% of the body surface covered in excrements)

[1] Categories inspired by (Smulders et al., 2006; Ursinus et al., 2014; Valros et al., 2020; Zonderland et al., 2008).
[2] Categories inspired by (Ursinus et al., 2014; Zonderland et al., 2009).
[3] Categories from (KTBL, 2016).

and response to primary needs was also considered physical activity. For instance, a pig lying on the floor during the 5 min of observation without performing any primary behaviours would receive a score of 1, and a pig standing, feeding, and sitting would receive a score of 6 (3 for standing, 1 for feeding, and 2 for sitting).

Wounds, cleanliness, and tail posture

The wounds, tail posture, and cleanliness of each pig in the observed group were recorded after the observation, from about 1600 to 1700, following the description in Table 3. The pigs were observed at close range. Usually, the observer stood directly behind the pen barrier, never more than a metre away from it. To observe pigs whose wounds, cleanliness and tail posture could not be recorded from the outside, the observer entered the pen. The quantity of lesions was divided into two groups (fewer than five and five or more). The cut-off at five scratches or wounds was based on the experience of a preliminary study and on Smulders et al. (2006). The classification was made in this way because one to two scratches can easily occur without the pig being involved in fights often. However, a pig that shows many scratches is more likely to

be involved in confrontations often. The severity of lesions (no lesion, superficial lesions or scratches, wounds, i.e., deep lesions, clearly visible fresh or dried blood, and part of the tail or ear missing) was inspired by Smulders et al. (2006); Ursinus et al. (2014) and Zonderland et al. (2008). The tails were generally not palpated, except when there was doubt in categorising the lesions, whether it was a wound on the tip of the tail or a piece of the tail was already missing. Tail posture (corkscrew, straight or hanging, and tucked between legs) was only observed when the pigs were standing before entering the pen. The categories used were based on Ursinus et al. (2014) and Zonderland et al. (2009). Cleanliness was categorised using a practical guide for assessing pig welfare (KTBL, 2016). The health status of the pigs on each observation day was considered, and each injured animal was treated on the same day.

Protein efficiency

The protein efficiency of the pigs was recorded at the time of slaughter by a different researcher (EOE) and was thus only known to the observer after the observations. The pigs were slaughtered at an average live BW of 105.27 kg (±6.00) at the Agroscope experimental abattoir in Posieux. The intestines and viscera, as well as the hair, blood, and gall bladder, were removed and the carcass cut in half. Protein efficiency was calculated as follows in Eq. (1):

$$protein\ \ efficiency = \frac{g\ \ protein\ \ carcass - g\ \ protein\ \ start}{g\ \ protein\ \ intake} \quad (1)$$

The protein content of the carcass (*g protein carcass*) was determined by scanning the left half-carcass with a dual-energy X-ray absorptiometry device, which gives the lean meat content. A regression equation (2) developed in a previous study (Kasper et al., 2021) was used to estimate the protein content of the carcass from the lean meat content according to dual-energy X-ray absorptiometry.

$$protein\ \ content\ \ carcass\ \ (g) = -482.745 + 0.23\ \ (g\ \text{lean tissue}\ \ DXA \times 2) \quad (2)$$

The protein content of pigs at the start of this experiment (*g protein start*) was estimated from a baseline protein content of the carcass at the transition from starter to grower feed (around 20 kg BW), which was determined in a previous experiment (Ruiz-Ascacibar et al., 2017). To estimate *g protein start*, we multiplied the actual live weight at the transition from starter to grower feed with this baseline. The amount of protein ingested (*g protein intake*) was calculated from the protein content in the diet and the amount of feed ingested, which was recorded automatically by the feeders between 20 kg BW and slaughter.

Ethics approval

All data were obtained in experimental conditions. All scientists and technicians involved in the experiments received initial training for experiments on live animals and are regularly retrained to maintain and refresh their capacities, in line with Swiss regulations governing experiments on animals. All procedures were conducted in accordance with the Ordinance on Animal Protection and the Ordinance on Animal Experimentation. The experimental procedure was approved by the Office for Food Safety and Veterinary Affairs (2018_30_FR, 30714).

Author ORCIDs

LR: https://orcid.org/0000-0001-9552-2992
EOE: https://orcid.org/0000-0002-9455-8325
CK: https://orcid.org/0000-0001-7305-3996

Author contributions

LR: Conceptualisation, Methodology, Data collection, Validation, Formal analysis, Software, Data curation, Writing - Original draft, Writing - Review and editing. **EOE:** Methodology, Data collection, Validation, Formal analysis, Data curation, Software, Writing - Review and editing. **CK:** Conceptualisation, Methodology, Formal analysis, Resources, Writing - Original draft, Writing - Review and editing, Supervision.

Declaration of interest

All the authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. CK is an editor at Animal Open Space.

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