Research in Veterinary Science 104 (2016) 200–206

Contents lists available at ScienceDirect

Research in Veterinary Science

journal homepage: www.elsevier.com/locate/rvsc

# Impact of the amount of straw provided to pigs kept in intensive production conditions on the occurrence and severity of gastric ulceration at slaughter

Mette S. Herskin [a,*], Henrik E. Jensen [b], Anna Jespersen [b], Björn Forkman [c], Margit B. Jensen [a], Nuria Canibe [a], Lene J. Pedersen [a]

[a] Aarhus University, Department of Animal Science, AU-FOULUM, Tjele, Denmark
[b] University of Copenhagen, Dept. Vet. Disease Biology, KU-SUND, Frederiksberg, Denmark
[c] University of Copenhagen, Dept. of Large Anim. Sci., KU-SUND, Frederiksberg, Denmark

ARTICLE INFO

*Article history:*
Received 28 April 2015
Received in revised form 25 November 2015
Accepted 22 December 2015

*Keywords:*
Pig
Gastric ulcer
Straw
Welfare

ABSTRACT

This study examined effects of the amount of straw offered on occurrence and severity of gastric lesions in pigs kept in pens (18 pigs, 0.7 $m^2$/pig) with partly slatted flooring and 10, 500 or 1000 g straw/pig/day from 30 kg live weight. The pigs had ad libitum access to dry feed. Forty-five pigs were used, three from each of 15 pens. After euthanization, the dimension of the non-glandular region of the stomach was measured. Lesions were characterized and scored. Irrespective of straw provided, 67% of the pigs showed signs of gastric pathology. Pigs provided with 500 or 1000 g straw were pooled as 'permanent access'. The proportion of pigs with ulcerations was reduced by permanent access to straw (7 vs. 33%; $P < 0.05$), suggesting that permanent access to straw may improve animal health, and be considered as one possible strategy to limit gastric ulceration in pigs.



## 1. Introduction

According to EU-regulations (EU Directive 2008/120/EC), pigs must have permanent access to a suitable material for manipulation and exploration. In these regulations, straw is mentioned as a suitable manipulable material for growing pigs, and in the literature concerning rooting materials for pigs, straw is the material which has received the most scientific attention (e.g., reviews by Studnitz et al., 2007; Van de Weerd and Day, 2009). One aspect of the provision of straw, which has only received limited scientific attention, is its potential effect on animal health. One health problem in intensive pig production is gastric ulceration, the economic loss from which is substantial due to subclinical haemorrhage and associated syndromes of anaemia, anorexia and weight loss (Friendship, 2006). Recent surveys examining gastric lesions at slaughter in various countries have reported ulcer prevalences of 32% (de Oliveira et al. (2010) examining almost 20,000 pigs at a Brazilian abattoir), 6% severe ulcers (in a sample of more than 9000 pigs at a UK abattoir (Swaby and Gregory, 2012)) and 11% ulcers in a sample of approximately 1000 Danish pigs (Nielsen et al., 2013).

The occurrence of gastric ulcers in pigs kept in intensive production systems is influenced by nutritional factors (Dirkzwager et al., 1998; Ayles et al., 1999; Scott et al., 2007). An important factor is the particle size of the feed; finely ground feed resulting in higher prevalence of gastric lesions than coarsely ground feed (Eisemann and Argenzio, 1999; Nielsen and Ingvartsen, 2000; Canibe et al., 2005). Animals fed finely ground feed have a more fluid stomach content than those fed the same feed but coarsely ground (Maxwell et al., 1970, 1972; Regina et al., 1999; Canibe et al., 2005). The consistency of the stomach content is considered a key factor affecting gastric ulcer prevalence (Regina et al., 1999; Ange et al., 2000). A fluid content allows the stratified squamous epithelium of the pars oesophagea region (the stomach region where gastric ulcer is most often seen in pigs) to come into contact with the luminal content of the distal part, where the concentration of acid, bile and pepsin is high. These are aggressive factors damaging the epithelium (Lang et al., 1998). In contrast, a more firm gastric content will mix much less and keep these compounds in the more distal stomach regions (Regina et al., 1999; Maxwell et al., 1970, 1972). Hence, nutritional factors leading to increased firmness of the stomach content are expected to prevent/reduce the development of lesions, whereas factors increasing the degree of fluidity, or leading to quicker emptying of the stomach, would increase the risk of lesion development. As ingestion of straw provides structure, pigs with sufficient access to straw may eat it, and thereby compensate for a lack of structure in the feed. In concordance with this hypothesis, provision of straw has been shown to ameliorate the ulcerogenic effects of feeding a finely ground diet (Nielsen and Ingvartsen, 2000).

In addition to the nutritional effects of straw provision, housing pigs in systems with access to straw can reduce the occurrence of gastric ulcers as compared to barren indoor conditions (Guy et al., 2002; Ramis et al., 2005; Amory et al., 2006). However, in these studies, the effects of straw have been confounded with other factors such as flooring,

* Corresponding author.
*E-mail address:* MetteS.Herskin@anis.au.dk (M.S. Herskin).

http://dx.doi.org/10.1016/j.rvsc.2015.12.017
0034-5288/

space allowance, air quality or group size. One study focused on effects of the provision of straw (approx. 0.4 kg/pig/day given to pigs on concrete flooring), and found limited occurrence of gastric lesions in these pigs compared to pigs kept on slatted floors and provided with a hanging toy (Scott et al., 2006). Furthermore, Bolhuis et al. (2007) gave a larger amount (>500 g/pig/day) of straw to pigs kept in metabolism chambers, leading to decreased occurrence of gastric lesions, and Di Martino et al. (2013) suggested that access to straw from racks acted as a protective factor for the development of gastric ulcers in heavy Italian pigs slaughtered at 170 kg. Hence, there are indications that straw has a beneficial effect on the occurrence and severity of gastric lesions in pigs. There is, however, a lack of data on the effect of amount of straw in growing pigs kept under conventional commercial conditions.

Thus, the aim of the present study was to examine the effects of amount of straw on the occurrence and severity of gastric lesions in pigs. We used data collected at slaughter from pigs kept in pens provided with 10, 500 or 1000 g straw/pig/day during the period from 30 kg to slaughter. The pigs were part of a larger study investigating the effects of straw on the behaviour of pigs. The effects of straw amount on the oral manipulation of pen mates and straw accessibility have been published by Pedersen et al. (2014), showing that 500 or 1000 g straw/pig/day resulted in permanent access to the straw, while 10 g straw/pig/day did not. We hypothesised that a larger proportion of pigs provided with 10 g straw/pig/day would show signs of gastric pathology, and that the severity of the gastric lesions would be higher in the pigs provided with 10 g straw/pig/day as compared to the pigs with permanent access to straw.

## 2. Material and methods

### 2.1. Animals, housing and management

The present experiment was conducted in the spring of 2011 in accordance with a protocol approved by the Danish Animal Experiments Inspectorate (Journal no. 2009/561-1729).

The data were collected at the resident barn at Department of Animal Science, Aarhus University, AU-FOULUM, Denmark. According to the Danish health control programme, the health status of the herd was Specific Pathogen Free, but not free of *Mycoplasma hyopneumoniae* or *Actinobacillus pleuropneumoniae* (AP 6 and 12). A total of 15 pens, each holding 18 clinically healthy crossbred LYD growing/finishing pigs were used, from which a sub-sample of 45 pigs, three from each pen, were examined for gastric lesions. The animals were born in conventional farrowing crates in a commercial Danish herd and fed and managed according to standard Danish practice (castration of males within the first week of life, tail docking all pigs within the 2nd to 4th day of life). Until weaning, each litter was provided with approximately 300 g uncut straw per day. After weaning, the pigs were kept in conventional weaner pens and provided with 10 g uncut straw per pig per day (given in one portion per pen on the floor) corresponding to the smallest amount of straw provided to them later in life. The health status of this herd was Specific Pathogen Free, but not free of *Mycoplasma hyopneumoniae*. The pigs were transported to the research facility (1 h drive) in standard lorries for porcine transport. Upon arrival, the weight of the pigs in the 15 experimental pens was 23 ± 4 kg (mean ± SD; range 18–31), and they were all checked visually for clinical signs of disease. The healthy pigs were distributed among the experimental pens, without balancing for gender.

The experimental period lasted from allotment to the experimental pens until slaughter at approximately 100 kg of body weight. During this period, the pigs were kept in one section equipped with 16 pens. The pigs were kept in pens measuring 5.48 × 2.48 m out of which 0.5 $m^2$ was occupied by a feeder. The flooring consisted of 1/3 solid concrete floor, 1/3 drained floor and 1/3 slatted floor. The number of pigs per pen was 18, corresponding to an animal density of 0.7 $m^2$ per pig.

The pigs were allowed ad libitum access to two commercial dry feeds for growing/finishing pigs from one feeder/pen, containing three feeding places. The composition of the two diets is shown in Table 1. The two diets were composed of 85% pellets and 15% non-heated and non-pelleted rolled barley. Further, 20% rolled wheat was included in the pellets of Diet 1. The remaining ingredients were ground in a hammer mill to pass a 3 mm sieve. The pellets, sized 3.5 mm, were manufactured by heating at a temperature of minimum 82 °C for 2 min, at a humidity of approximately 13.5%. From the beginning of the study and until a body weight of 55 kg, the animals were fed Diet 1 and from 55 kg to the end of the study (at approximately 100 kg body weight), Diet 2. The feeders were filled automatically three times per day (at 03, 10 and 19 h). Each pen was equipped with two drinking nipples, the functionality and water flow of which were checked daily. Inflow of natural light through windows was blocked (in order to facilitate video recordings for another project) and the barn was lit by artificial light from 06 to 22 h.

The health condition of the pigs was monitored on a daily basis, ensuring medical treatment of pigs with clinical signs of disease as well as removal of diseased pigs to sick pens. The tails of all pigs were checked daily for lesions.

### 2.2. Experimental design

The experimental treatments consisted of provision of 10, 500 or 1000 g whole straw/pig/day. No other enrichment or manipulable materials were available. The three different experimental treatments were equally distributed within the section, ensuring that no treatment was placed systematically near doors or outer walls.

The gastric pathology data were obtained from three pigs from each of the 15 pens (in order to include pigs of relatively low, intermediate and high body size within the pens, but not balanced for gender). Upon arrival, one pig was randomly chosen among the six lightest pigs in each pen, one randomly chosen among the six pigs in the middle weight interval and one randomly chosen among the six heaviest pigs in the pen. The experimental pigs were marked individually for identification (done weekly, by use of pig spray). Thus, the dataset consisted of stomachs from 18 pigs provided with 10 g straw/pig/day (three pigs from each of six pens), 12 pigs provided with 500 g straw/pig/day

**Table 1**
Composition of the diets given to the growing/finishing pigs on as-fed basis (g $kg^{-1}$ feed).[a]

| Item | Diet 1 | Diet 2 |
|---|---|---|
| Wheat | 219.0 | 400.0 |
| Rolled wheat | 200.0 | – |
| Dehulled toasted soybean meal | 175.0 | 64.0 |
| Rolled barley[b] | 150.0 | 150.0 |
| Barley | 150.0 | 100.0 |
| Rapeseed cake | – | 100.0 |
| Partially dehulled sunflower cake | – | 50.0 |
| Wheat bran | 49.0 | 41.0 |
| Triticale | – | 33.0 |
| Sugarcane molasses | 20.0 | 25.0 |
| Calcium carbonate | 13.3 | 12.0 |
| Palm oil | 7.0 | 8.0 |
| Vitalys[c] | 4.7 | 7.1 |
| Sodium chloride | 4.5 | 4.2 |
| Monocalcium phosphate | 4.0 | 2.3 |
| Vitamin and mineral premix | 2.0 | 2.0 |
| Threonine, 98/100% | 0.5 | 0.7 |
| Xylanase[d] | 0.5 | 0.4 |
| DL-Methionine, 100% | 0.3 | – |
| Phytase[e] | 0.2 | 0.3 |

[a] Diet 1: offered from the beginning of the study until 55 kg body weight; Diet 2: offered from 55 kg body weight to the end of the study (ca. 100 kg body weight).
[b] Non-heated and non-pelleted.
[c] Fermentation product containing lysine sulphate and other fermentation metabolites.
[d] Supplying 3200 U/kg feed.
[e] Supplying 1000 FTU/kg feed.