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Effect of feed processing on growth performance and gastric mucosa integrity in pigs from weaning until slaughter

S. Millet[a,*], S. Kumar[b], J. De Boever[a], R. Ducatelle[b], D. De Brabander[a]

[a] *Institute for Agricultural and Fisheries Research (ILVO), Animal Sciences Unit, Scheldeweg 68, 9090 Melle, Belgium*
[b] *Ghent University, Faculty of Veterinary Medicine, Research Group on Veterinary Public Health and Zoonoses, Department of Pathology, Bacteriology and Avian Medicine, Salisburylaan 133, 9820 Merelbeke, Belgium*

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ABSTRACT

The effect of technological treatments on the performances from 1 week after weaning until slaughter and on the gastric mucosa integrity of growing-finishing pigs at slaughter was investigated. We compared a diet expanded at high pressure and temperature (expandate) with a diet expanded under milder conditions that was subsequently pelleted and crumbled (crumble) and an untreated control diet (meal). At weaning, a total of 180 pigs (8.4 ± 0.8 kg) were divided over 30 pens of 6 animals, with 10 pens per treatment. Feed structure had a clear impact on performance results. However, while the expanded and the crumbled feed was used more efficiently ($P=0.003$), feed intake was considerably higher on the meal feed ($P=0.003$). Between start and slaughter, this led to a similar growth in the three groups ($P=0.898$). Apparent faecal digestibility of dry matter ($P=0.843$) or crude protein ($P=0.726$) did not differ between the diets. The ulcer score was affected by the feed structure ($P<0.001$). Pigs on the meal diet had the lowest ulcer score, those on the expandate an intermediate score and those on the crumbled diet the highest score, with all diets being significantly different from each other ($P<0.05$). The number of *Helicobacter suis* bacteria per gram of mucus was lower on the meal than on the expandate or the crumbled feed.

In conclusion, it can be stated that expanding and pelleting improved feed efficiency of growing-finishing pigs. However, these technological treatments had a negative impact on gastric mucosa integrity and were associated with an increased *H. suis* colonisation.

1. Introduction

In animal feed production, technological treatments can improve the digestibility of the feed and the efficiency of growth. Pelleting has long been known to improve feed efficiency (Jensen and Becker, 1965). Expansion, when used as a pre-pelleting conditioning step, yields technological benefits such as improved physical pellet quality and decreased expenditure of energy during pelleting (Vande Ginste and De Schrijver, 1998). While these treatments may yield benefits in terms of performance, they also involve costs for energy and equipment. Therefore, feed manufacturers have to consider possible tradeoffs between the cost of a technological treatment and the expected benefit in terms of performance.

A treatment may not only affect performance, but also the health or welfare of an animal. While finely grinding the feed improves performance, it also increases the risk of developing gastric ulcers (Wondra et al., 1995; Millet et al., 2012).

Abbreviations: ADIN, acid detergent insoluble nitrogen; CGM, capteur gras/maigre; PCR, polymerase chain reaction.

* Corresponding author. Tel.: +32 9 2722612; fax: +32 9 2722601.
E-mail address: sam.millet@ilvo.vlaanderen.be (S. Millet).

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Mortality due to bleeding gastric ulcers leads to economic losses on pig farms. Technological treatments affect the structure of the feed. Pelleting and crumbling can reduce the particle size of the diet (Wolf et al., 2010) and therefore probably increase the risk of gastric ulceration. It follows that expanding may also affect the feed structure and therefore affect the risk for gastric ulceration.

Infection with *H. suis* is associated with gastric ulceration in pigs (Queiroz et al., 1996; Haesebrouck et al., 2009). The prevalence of this bacterium in slaughter pigs varies from 60 to 80% (Melnichouk et al., 1999; De Groote et al., 2000). The influence of feed structure on *H. suis* incidence has not been reported before, although the number of positive urease tests (as an indicator for *H. suis*) has been lowered by coarsely grinding a feed (Millet et al., 2012).

In the present experiment, we aimed to compare (1) a diet expanded at higher pressure and temperature, (2) a diet expanded under milder conditions that was subsequently pelleted and crumbled and (3) untreated meal (control diet) on performance traits, gastric mucosa integrity and prevalence of *H. suis*.

2. Materials and methods

2.1. Animals and management

The experiment was conducted as a randomized complete block design, in two consecutive weaning rounds (blocks) separated by a period of three weeks. In each block, 90 weanling pigs (Piétrain boar × Rattlerow-Seghers hybrid sow) with an average body weight of 8.4 ± 0.8 were selected and divided over 15 pens of 6 piglets (3 barrows and 3 gilts per pen), with a total of 10 pens per treatment. For this selection, the gilts and barrows closest to the average bodyweight were selected. Three barrows and three gilts were randomly assigned to one pen. Then, each pen was randomly assigned to one out of three dietary treatments: meal, expandate or expanded then crumbled feed.

The experiment started 5 days after weaning. One pen measured 1 m × 1.8 m (1.8 m^2) so that the surface per piglet amounted to 0.3 m^2. The slatted floor was covered with a synthetic coating. The temperature in the compartments ranged from 26 °C at the start to 22 °C at 9 weeks; the light schedule had natural daylight and supplemental artificial light between 7:30 h and 15:30 h.

At an age of 9 weeks, the pigs were moved to the fattening barn. The pigs were maintained in the same pen groups. One pen measured 7.5 m^2 (2.9 m × 2.6 m) so that the surface per pig amounted to 1.26 m^2. These pens had 50% concrete and 50% slatted floors. The temperature was kept constant at 18 ± 2 °C. The pigs stayed in this barn until slaughter at an intended weight of 110 kg. They were slaughtered in a commercial slaughterhouse.

2.2. Feeds

All piglets received the same diet (10 MJ net energy, 12.3 g ileal digestible lysine) until the start of the experiment (5 days after weaning). This was a commercial meal feed for young pigs.

The piglets received a starter feed from 5 until 9 weeks of age, a grower feed from 9 until 15 weeks of age and a finishing feed from 15 weeks until slaughter. Ingredient and nutrient contents of the experimental diets are given in Table 1. Experimental diets within a feeding phase only differed in technological treatments and type of phytase added, but not in ingredient composition. For the expandate and the crumble, the phytase was added in liquid form after the heat treatment. The three feeding phases differed mainly in amino acid and fibre content. The meal feed was produced using a hammermill at 1500 rpm with a screen of 4 mm. The expandate was produced using a hammermill at 1500 rpm with a screen of 4 mm, a conditioner, an expander (70 bar; temperature after the expander: 124 °C) and a cooler. This expandate did not have a well-defined shape or size. The crumbled feed was produced using a hammermill at 1500 rpm with a screen of 4 mm, a conditioner, expander (65 bar; temperature after expander 90 °C), press, cooler and crumbler (crumble size was slightly larger than the expandate).

2.3. Measurements

2.3.1. Feed characteristics

All diets were subject to proximate analysis (EEC, 1971a,b; EC, 1992, 1993). The neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin were determined according to Van Soest et al. (1991). Insoluble ash was determined as described by McCarthy et al. (1974). Samples were boiled with 4 N HCl, then the mixture was filtered and the filter with residue ashed at 650 ± 25 °C. Particle size distribution of the pellets was measured in duplicate using a wet sieve analysis. Fifty gram of the feed was placed in a tumbler, then 1000 mL water at 30 °C was added to the feed. After 30 min the mixture was stirred with a spatula and after another 30 min the feed/water suspension was deposited onto the top of a sieve tower. The tower was placed on a bowl with a downspout, then washed with 10 L cold, distilled water (water pressure of 1 bar). The sieve tower was dried in a ventilated oven (65 °C) overnight, then cooled in a dessicator and each sieve was weighed again.

To investigate whether feed processing provoked heat damage that lowered the protein quality, the acid detergent insoluble nitrogen (ADIN) content was determined according to Licitra et al. (1996).