



Effect of feeding fermentable fibre-rich feedstuffs on meat quality with emphasis on chemical and sensory boar taint in entire male and female pigs

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ABSTRACT

Skatole, androstenone and other compounds such as indole cause boar taint in entire male pork. However, female pigs also produce skatole and indole. The purpose of this experiment was to minimise boar taint and increase overall impression of sensory quality by feeding entire male and female pigs with fibre-rich feedstuffs. The pigs have been fed three organic diets for either 1 or 2 weeks prior to slaughter of which two diets contained different fermentable fibre-rich feedstuffs – 10–13.3% dried chicory roots or 25% blue lupines. These two treatments were compared with pigs fed with an organic control diet for either 1 or 2 weeks prior to slaughter. Lupines significantly reduced skatole in blood and backfat for both genders after 1 week. Moreover, lupines showed negative impact on growth rate and feed conversion whilst chicory showed no significant differences in this respect. However, the indole concentration was significantly lower in chicory than lupine fed pigs. From a sensory perspective, chicory and lupine feeding reduced boar taint since odour and flavour of manure related to skatole and urine associated to androstenone were minimised. The level of boar taint in the entire male pigs was most effectively reduced after 14 days by both fibre-rich feeds while lupine had the largest influence on “boar” taint reduction in female pigs.

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1. Introduction

Boar taint is primarily caused by skatole and androstenone and other compounds such as indole (EFSA, 2004; Mortensen & Sørensen, 1984; Patterson, 1968). Skatole is produced by both male and female pigs from the metabolism of the amino acid tryptophane in the large intestine and indole is like skatole a breakdown product of tryptophane while androstenone is a male steroid pheromone (EFSA, 2004; Zamaratskaia, 2004; Aldal et al., 2005).

Different feeds have been tested for their effect on skatole levels in the digestive tract, faeces and backfat (Claus, Lösel, Lacorn, Mentschel, & Schenkel, 2003; Claus, Weiler, & Herzog, 1994; Hansen et al., 2006; Jensen & Jensen, 1998; Jensen, Cox, & Jensen, 1995; Lösel, Lacorn, Buttner, & Claus, 2006; Zamaratskaia, Babol, Andersson, Andersson, & Lundström, 2005). Additions of non-digestible oligosaccharides, fructo-oligosaccharides/inulin (FOS) in the diet have been shown to decrease skatole levels in faeces, backfat and blood (Claus et al., 1994; Jensen & Jensen, 1998). Han-

sen et al. (2006) tested the influence of crude and dried chicory roots, which have a high content of inulin (FOS), on skatole levels in plasma and backfat. The skatole concentration in the plasma was reduced to low levels after only 3 days of feeding 25% dried chicory roots and decreased further after 7 days and remained at a very low level until the end of the feeding period for both crude and dried chicory. The skatole equivalent in the backfat at slaughter was also very low in both crude and dried chicory fed pigs. The results for chicory fed pigs were similar to those fed purified inulin, indicating that inulin (FOS) is the main component of chicory and responsible for the skatole reduction (Hansen et al., 2006). Further, studies have demonstrated that 10% dried chicory or more in the feed significantly reduced skatole in the blood and backfat of entire male pigs after 7, 14 and 21 days of feeding. This resulted in a significant reduction in perceived boar taint, related to skatole, and thus improved the flavour and taste of meat produced from entire male pigs (Byrne & Hansen, 2005; Hansen, 2005). Also, 25% lupine-based diet during the whole fattening period has been shown to reduce skatole levels in castrated male and female pigs (Claudi-Magnussen & Hansen, 2005; Hansen & Claudi-Magnussen, 2004).

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Sensory profiling, a method in which a panel uses a developed sensory vocabulary to describe perceived sensory characteristics in a sample set, has previously been applied in the evaluation of the level of boar taint (Dijksterhuis et al., 2000; Banon, Costa, Gil, & Garrido, 2003; Byrne, Thamsborg, & Hansen, 2007). Sensory boar taint is perceived during cooking and eating, and is described as having a distinctive and unpleasant characteristic odour and flavour (EFSA, 2004). Skatole is mostly associated with sensory descriptors such as manure and androstenone is mostly related to urine (Dijksterhuis et al., 2000). The results from a sensory profiling can be interpreted alone or in combination with for instance chemical measurements to elucidate possible underlying predictive and causal relationships.

The aim of the present study was to investigate the effect of feeding 10% dried chicory roots and 25% blue lupine seeds for 7 or 14 days prior to slaughter on skatole and indole levels in backfat as well as on sensory quality of *M. longissimus dorsi* muscle (LD). Further, production results were registered and meat quality parameters were measured on the LD. The focus of the study was on the effect of the non-digestible oligosaccharides on skatole and indole. Thus, androstenone was not involved since a previous experiment by Hansen et al. (2006) found that feeding chicory did not affect androstenone levels except in one of three trials. However, sensory descriptors such as urine odour and flavour corresponding to androstenone were included in the sensory profiling to enable tracking of this aspect.

2. Material and methods

2.1. Animals and housing

Forty eight Danish crossbreed pigs of Duroc sires and crossbreed dam Danish Landrace × Large White (DLY) were produced at the Organic Research Station Rugballegård, Horsens, Denmark. The female and entire male pigs were kept in separate stables to avoid early sexual maturity and possibly elevated levels of androstenone in the male pigs. The pens were kept clean to avoid increased skatole and indole concentration in the subcutaneous fat (Hansen, Larsen, Jensen, Hansen-Møller, & Bardon-Gade, 1994).

2.2. Dietary treatments

Before initiation of the experiment, the pigs were fed an organic certified concentrate diet according to Danish recommendation for growing pigs (Madsen, Petersen, & Soegaard, 1990) and ad libitum clover grass silage. The experiment proper then consisted of two replicates each including 24 pigs (12 males and 12 females). At an avg. live weight of 90 kg, the pigs were assigned to one of the three feeding treatments (control (CON), dried chicory (DC), lupine (LUP)) according to their initial live weight, litter and gender (Table 1). The pigs were weighted on day 0, before they received

the experimental diet. They were weighted again on day 7 and the heaviest from each pen was slaughtered the next day (day 8). The remaining pig was slaughtered on day 15. The calculated live weight at slaughter (warm carcass weight × 1.35) was between 100 and 108 kg. Independent of the treatment, the pigs were fed with 3 kg per day, which is around 95% according to the Danish scale for finishing pigs (Madsen et al., 1990). The control feeding (CON) consisted of 100% organic concentrate. For the chicory feeding (DC), the inulin-rich variety of chicory (*Cichorium intybus* L. var Orchies) was dried at a temperature just below 65 °C for 48 h. DC consisted of 10% dried chicory plus 90% organic concentrate at the first experimental replicate and 13.3% dried chicory plus 86.7% organic concentrate at the second replicate. The amount of dried chicory roots was increased from 10% to 13.3% in the DC diet in the second replicate because the level of skatole equivalents in backfat from the pigs in the first replicate was not significantly decreased compared to the control (CON) fed and at the same time it was found by several analyses of the dried chicory used for this experiment that it contained less fructans (inulin) (avg. around 36%), compared to around 46% in earlier experiments. The 13.3% dried chicory in the second replicate was mixed with the pelleted control (CON) feed just before the delivery of the meal. The chicory fed pigs were not supplied with further protein as the protein requirement for finishing pigs was fulfilled (Danish Bacon & Meat Council, 2002). The lupine feeding (LUP) consisted of 25% lupine plus 75% organic concentrate (see Table 2). A commercial variety of blue lupines (*Lupinus angustifolius* var. Prima) was used.

The three diets were conditioned shortly at 80 °C according to the Danish regulation for destroying any possible Salmonella contamination before agglomeration. All the feeding types were provided to the pigs pelleted except from the 13.3% dried chicory in the second replicate of the experiment, which were not conditioned at 80 °C. The composition and the nutrient content of the control and the two experimental diets are presented in Table 2.

2.3. Slaughter procedure

On the day of slaughter, the pigs were transported from the Organic Research Station at Rugballegård to the experimental abattoir at Research Centre Foulum (100 km), by a special truck for animal transportation. All pigs arrived to the abattoir of Research Centre Foulum at 8.00 a.m. after 1.5 h of transport from Rugballegård. The pigs were slaughtered in two groups according to their sex (first the males) and in random order according to their treatment (diet) within the sex groups. The pigs were stunned by 85% CO₂ for 3 min, exsanguinated, scalded at 62 °C for 3 min. Thereafter, they were cleaned and eviscerated. The whole procedure lasted 30 min. Unchilled carcasses were split in two equal halves and placed in a room at 12 °C. One hour after exsanguination, the carcasses were placed in the chill room at 4 °C, with intermittent airflow. Normally 4 °C is reached approximately in 12 h post-mortem

Table 1
Experimental design for the feeding period of the three treatments with organic concentrate, dried chicory and blue lupine of 1 or 2 weeks

Replicate ^a	Treatment	No. of pigs	Experimental units	Feed composition
1	Control (CON)	8	4 Pens of 2 pigs ^b	100% Organic concentrate
	Chicory (DC)	8	4 Pens of 2 pigs ^b	90% Organic concentrate + 10% dried chicory
	Lupine (LUP)	8	4 Pens of 2 pigs ^b	75% Organic concentrate + 25% blue lupine
2	Control (CON)	8	4 Pens of 2 pigs ^b	100% Organic concentrate
	Chicory (DC)	8	4 Pens of 2 pigs ^b	86.7% Organic concentrate + 13.3% dried chicory
	Lupine (LUP)	8	4 Pens of 2 pigs ^b	75% Organic concentrate + 25% blue lupine
Total		48	24 Pens of 2 pigs	

^a Experimental replicate 1 and replicate 2 were executed with 1 month in between each other.

^b 2 pens with males + 2 pens with females in gender separated stables. The heavier of the two pigs in a pen was slaughtered after a 1 week feeding period and remaining part after 2 weeks feeding period.

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