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The effects of method of castration, rearing condition and diet on sensory quality of pork assessed by a trained panel

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ABSTRACT

Beside surgical castration possible alternatives helping to reduce the incidence of boar taint in cooked pork are rearing conditions, immunocastration and feeding strategies for entire males known to lower the skatole levels. The goal of this study was to assess the effects of these alternatives on the sensory acceptability of pork. In experiment 1, carcasses from barrows, entire males (EM) and entire males fed raw potato starch (EM+) 7 d before slaughter were selected based on the androstenone (≤2 μg/g) and skatole (≤0.32 μg/g) levels. In experiment 2, carcasses from barrows, immunocastrates (IC), entire males either group-penned (EMG) or individually penned (EMP) were selected based on the aforementioned criteria. Boar odour and boar flavour intensities of *longissimus dorsi* (LD) and neck chops were evaluated by trained panellists. Boar odour and flavour scores were higher ($P<0.01$) in neck than LD chops. Although skatole tissue levels in barrows and EM+ were similar ($P>0.05$), boar odour and flavour scores were greater ($P<0.05$) in EM+ than barrows. In experiment 2, scores for boar odour and flavour were lower ($P<0.05$) in pork from barrows and IC than EMP, with intermediate values for EMG. In conclusion, we observed a discrepancy between the known boar taint compounds androstenone and skatole and sensory acceptability, which indicates that other factors influenced the perception of boar taint. Thus, surgical castration with or without anesthesia or immunocastration are still the safest methods to avoid boar taint.

1. Introduction

Boar taint is an off-flavour and off-odour of pork. Today, surgical castration is the most common method to reduce the incidence of boar taint. Castration of young male piglets without anesthesia will be prohibited in Switzerland in 2010 and in various European countries (Sweden, The Nederland, Belgium, Denmark and Germany), this issue is high on the political agenda. Boar taint is mainly caused by elevated concentrations of androstenone [α-androst-16-en-3-one; A] (Patterson, 1968), skatole [3-methyl-indole; S] and/or indole [indole; I] (Vold, 1970; Walstra & Maarse, 1970) in the adipose tissue. Androstenone is a testicular steroid with a urine-like odour. Its tissue concentration depends on age, body weight (BW), breed and sexual maturity of the pig as well as on feeding regime, rearing conditions and season [light regimen] (Bonneau, 1982; Claus, Weiler, & Herzog, 1994; Whittington et al., 2004). Skatole and I, which are characterized by a faecal-like odour, are produced as natural microbial metabolites of tryptophan in the hind-gut of pigs. Their levels in the adipose tissue depend mainly on the nutrient composition of the diet and rearing conditions of pigs (Babol, Zamaratskaia, Juneja, & Lundström, 2004; Hansen, Larsen, Jensen, Hansen-Møller, & Barton-Gade, 1994; Jensen, Cox, & Jensen, 1995). Furthermore, Doran, Whittington, Wood, and McGivan (2002) showed that A and S tissue levels are related because high A levels antagonise the induction of CYP2E1 expression by S and this ultimately leads to high S accumulation. Feeding strategies like supplementing raw potato starch (Mentschel & Claus, 2003; Pauly, Spring, O'Doherty, Ampuero Kragten, & Bee, 2008; Zamaratskaia, Babol, Andersson, Andersson, & Lundström, 2005) or sugar beet pulp (Jensen et al., 1995) a few days before slaughter have proven to be effective in reducing S but not A or I tissue concentrations, by altering the composition and fermentative activity of the intestinal microflora.

As previously mentioned and reported in various studies (Annor-Frempong, Nute, Whittington, & Wood, 1997b; Bonneau et al., 2000; Xue, Dial, Holton, Vickers, Squires, Lou, Godbout, & Morel et al., 1996a) both A and S are important for the perception of boar taint in pork. However, results on what proportion each of the two substances contributes to boar taint are partially conflicting. In the past, many studies have indicated that the contribution of S was more important for boar taint perception (Lundström et al., 1988; Walstra, Engel, & Mateman, 1986). By contrast others suggested that A was more

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important or that A and S were equally relevant (Bonneau, LeDenmat, Vaudelet, Nunes et al., 1992b; Xue, Dial, & Morrison, 1996b). Thus, our first aim was to establish the impact of reduced S tissue content on the incidence of boar odour and boar flavour in pork of entire males. To achieve reduced S tissue levels, a dietary approach was used by supplementing the finisher diet with raw potato starch (RPS).

Immunization against gonadotropin-releasing factor (GnRF) suppresses testicular activity leading to low A concentrations in the adipose tissue (Dunshea et al., 2001; Jaros et al., 2005; Zeng et al., 2002). The reduction of testicular steroids in immunocastrates also accelerate the metabolic clearance of indolic compounds, thus, resulting in lower S and even I tissue levels (Zamaratskaia et al., 2008). Regarding sensory acceptability, Font i Furnols et al. (2008) found no differences in off-odour or off-flavour of pork from barrows and immunocastrates. Therefore, the second goal of this study was to test whether boar odour and boar flavour would be similar in pork from barrows and immunocastrates when A, S and I levels in the adipose tissue were lowered due to immunization. In addition the impact of rearing condition of boars and its effect on the aforementioned traits were also assessed.

As the key compounds involved in boar taint are deposited in the adipose tissue and fat levels vary between cuts, it is likely that boar taint perception varies between cuts of the same animal (Weiler, Dehnhard, Herbert, & Claus, 1995). Clausen and Ovesen (2001) stated that neck chops contain more fat than loin chops. Therefore, in this study sensory evaluation of pork from entire males, immunocastrates and barrows was performed in neck as well as in loin chops and not limited to odour and flavour but also juiciness and tenderness were included as important sensory traits.

2. Materials and methods

2.1. Experiment 1: animals

Meat samples were selected from our recent study (Pauly et al., 2008). Briefly, 36 Swiss Large White pigs from 12 litters were blocked by litter and assigned by BW to three experimental groups: barrows (C1), entire males (EM) and entire males offered RPS (30 g RPS/100 g diet) for 7 d prior to slaughter (EM+). Pigs, which were group-penned, had *ad libitum* access to the feed from 22 to 107 kg BW. Individual feed intake was recorded daily and BW once a week. Pigs were reared separately by experimental group. The pigs were slaughtered the wk in which they reached 103 kg BW. For the sensory evaluation, 18 pigs (6 per treatment) were selected based on A and S tissue concentrations. Only litters were included in the study from which all animals had A and S adipose tissue concentrations of ≤ 2 and ≤ 0.32 μg/g tissue, respectively. These concentrations were 2-fold higher as the sensory thresholds suggested by Walstra et al. (1999) for A and Bee and Piccinali (2006) for A and S, respectively.

2.2. Experiment 2: animals

Meat samples were collected from our recent study (Pauly, Spring, O'Doherty, Ampuero Kragten, & Bee, 2009). Briefly, 52 Swiss Large White pigs were blocked after weaning by litter and assigned by BW to four experimental groups: barrows (C2), immunocastrated male pigs (IC), entire male pigs reared in group pens (EMG) and entire male pigs reared in individual pens (EMP). All pigs had *ad libitum* access to standard diets from weaning to 107 kg BW. The IC pigs were vaccinated twice with 2 ml of Improvac® (Pfizer Ltd., Zurich, Switzerland) given subcutaneously in the neck at an average BW of 22.2 and 74.3 kg. Applying the same threshold levels for A and S as in experiment 1, carcasses of 11 litters ($N = 44$) were selected.

2.3. Analysis of androstenone, skatole and indole in the adipose tissue

The A, S and I concentrations in the adipose tissue, which was collected the day after slaughter from the right carcass side at the 10th to 13th rib level, were determined by high-performance liquid chromatography (HPLC) as described previously (Pauly et al., 2008) and their levels were expressed as μg/g adipose tissue.

2.4. Sampling and sample preparation

One day post-mortem about 1 kg each of the *longissimus dorsi* muscle (LD, 13th to 15th rib level) and the neck (containing *Trapezius* and LD muscle, 5th to 7th rib level) were collected from the right carcass side of the selected animals. The meat was trimmed to have <3 mm subcutaneous fat, packed and stored for 48 h at 4 °C. Subsequently, purge was removed and the LD and neck cuts were vacuum-packed and frozen at −20 °C for three months. The frozen meat was cut into 1 cm-thick slices. The first cuts were discarded. Each slice was then separately vacuum-packed again and stored at −20 °C. During the whole process meat did not thaw.

The day prior to the sensory test, two chops from the LD and two from the neck were thawed at 4 °C for 24 h and kept for at least 1 h at 17 °C. Subsequently, the LD and neck chops were cooked on a grill plate (Beer Grill AG, Zurich, Switzerland) at 190–195 °C for 4 and 4.5 min, respectively. Measured internal temperatures of the samples were on average 69 °C. No spices were added. During cooking, it was avoided that melting intra- and inter-muscular fat on the grill plate from one chop got in contact with other chops.

For serving, the chops were cut into strips of 2×4 cm. First cuts were removed. Each panellist was served three (experiment 1) and four (experiment 2) randomized pieces of meat on a multi-compartment preheated plate. Each cooked sample was covered separately with a glass top and labeled with a three-digit number.

2.5. Sensory analysis

2.5.1. Selection of panellists and training

The sensory study was carried out at the sensory laboratory of Agroscope Liebefeld-Posieux Research Station (ALP; Posieux, Switzerland). Personnel of the research station were selected as panellists. In order to exclude anosmic panellists, the main selection criteria was their ability to detect A. The selection was based on a triangle test with a solution containing 1 μg/g A diluted in methanol. All panellists were familiar with sensory assessment of meat. Nevertheless, prior to the first experimental session, they conducted an additional basic training program in sensory assessment. After this basic training, panellists were specifically trained in two sessions on boar taint. In the first session, the profiles of sensory attributes of boar taint were taught with sunflower oil spiked with the synthetic compounds (Sigma-Aldrich Chemie, Buchs, Switzerland) A (5.0 and 1.0 μg/g), S (0.30 and 0.15 μg/g) and I (0.30 and 0.15 μg/g). Mixed solutions (1.5 A + 0.16 μg/g S; 1.0 A + 0.25 μg/g S; 0.5 A + 0.16 μg/g S) in sunflower oil were also provided for evaluation. Solutions were heated in a microwave oven (Combi quartz 1700, Koenig, Zürich, Switzerland) for 2 min at 300 W. Panellists were informed about the composition of the samples and had an information sheet with the sensory attributes to the terms A, S, I and "pig/animal" at their disposal (Annor-Frempong, Nute, Whittington, & Wood, 1997a). Furthermore, they were encouraged to add additional attributes. In the second session, they were instructed to evaluate boar odour, boar flavour, juiciness and tenderness. The LD and neck chops from pigs with low (A: ≤ 0.5 and S: ≤ 0.12 μg/g), medium (A: 1.0 or 1.1 and S: 0.13 or 0.16 μg/g) and high (A: ≥ 2.5 and S: ≥ 2.5 μg/g) A and S concentrations in the adipose tissue (Table 1) were cooked as described previously and given to the panellists with information on the concentrations of the samples. The day after the second training