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Prevalence of boar taint in commercial pigs from Spanish farms

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ABSTRACT

The presence of boar taint can affect the sensory quality of pork because the "off" odours and flavours can be detected by consumers. The aim of this study was to determine the prevalence of boar taint in pig carcasses from 30 Spanish farms located in different regions of the country. Hot carcass weight and subcutaneous fat thickness means were 79.4 ± 8.19 kg and 18.4 ± 5.09 mm, respectively. Subcutaneous fat samples were classified into different levels according to androstenone and skatole concentrations in adipose tissue measured using GC–MS and HPLC. Androstenone results were: 87.4% of the carcasses below 0.50 μg/g, 7.1% from 0.50 to 1.00 μg/g (medium level), and 5.5% ≥1.00 μg/g (high level). Skatole results were: 88.9% of the carcasses below 0.10 μg/g, 4.5% from 0.10 to 0.20 μg/g (medium level), and 6.6% ≥0.20 μg/g (high level). Given these results, a future online method to classify carcasses according to boar taint is strongly recommended.

1. Introduction

Boar taint is a distinctive and unpleasant odour and taste of pork and pork products and is present in some entire male pigs. It is caused mainly by an excessive accumulation of certain volatile compounds linked to the sexual maturity of pigs (Bonneau, 1982). Therefore the rearing of entire male pigs is avoided in most European countries, and the majority of male piglets intended for pork production are surgically castrated to avoid potential consumer dissatisfaction because of boar taint (Fredriksen et al., 2009). However, entire male pig production is more profitable for farmers due to leaner carcasses and a higher protein content, compared to castrated pigs (Lundström, Matthews, & Haugen, 2009). Due to EU legislations, surgical castration has recently been discontinued in an increasing number of European countries, and discussions at European level are aiming to ban surgical castration by 2018 (DG-SANCO, 2010). Because of these reasons, since 2012, some countries such as Germany, The Netherlands and Denmark have already changed their production to entire males.

In Spain, pig production is a major industry and over 40 million pigs are slaughtered per year, representing 16% of European production (FAOSTAT, 2013). In 2009 the practise of castration in Spain was estimated to have been performed on 33% of male pigs (Fredriksen et al., 2009). Currently, as a consequence of the changes in the production model this percentage can be assumed to be lower. Nowadays, castration is approximately 15–20% according to the pig sector (Borrisser-Pairó et al., 2014).

The presence of boar taint is due to high concentrations in the fat of at least one of the two compounds widely accepted to be responsible for tainted pork: androstenone and skatole (Bonneau, 1982). Androstenone (5α-androst-16-ene-3one) is a pheromone produced in the testes and exhibits a urine-like odour, which was isolated from boar fat by Patterson (1968). Skatole (3-methylindole) is a breakdown product of the amino acid tryptophan in the large intestine, exhibiting a faecal-like, naphthalene odour, which was isolated from boar fat by Vold (1970).

Some pigs show levels of these compounds in the adipose tissue over the threshold from which sensory problems can arise (Font i Furnols, Guerrero, Serra, Rius, & Oliver, 2000). The most commonly used cut-off levels for androstenone to categorize tainted meat are 0.5 and 1.0 μg/g of adipose tissue respectively, as suggested in previous studies (Claus, Weiler, & Herzog, 1994; Font i Furnols, Gispert, Diestre, & Oliver, 2003; Rhodes, 1971); whilst for skatole the most commonly used threshold values are 0.10 and 0.20 μg/g of adipose tissue (Bonneau et al., 1992; Claus et al., 1994; Desmoulin, Bonneau, Frouin, & Bidard, 1982; Font i Furnols et al., 2003; Walstra et al., 1999).

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Malmfors and Hansson (1974) studied the prevalence of boar taint in Swedish Landrace and Yorkshire boars by smelling fat samples heated with a soldering iron. They found that 20% of boars presented boar taint. In a European study by Walstra et al. (1999) conducted in six countries, the amount of pigs presenting levels over the thresholds of 1.0 μg/g for androstenone and 0.20 μg/g of adipose tissue for skatole, were approximately 29% and 15% respectively. In Spain particularly, pigs over these thresholds were approximately 42% for androstenone, and 30% for skatole. Prusa et al. (2011) assessed the prevalence of boar taint in commercial abattoirs in different regions of The United States by evaluating fat samples from gilts, sows, barrows and boars with a trained panel and also with chemical analyses. They found that 55.8% and 34.2% of boars had concentrations above the androstenone and skatole thresholds, respectively.

To the best of the authors' knowledge, since Walstra et al. (1999) no updated data has been published in relation to the prevalence of boar taint in the Spanish pig population. Pig production is the most important livestock activity in Europe, particularly in Spain (FAOSTAT, 2013). DG-SANCO is planning to ban surgical castration by 2018 (DG-SANCO, 2010), so Europe is moving towards entire male production. It is relevant to know, as a first step, the percentage of entire male pigs with high levels of boar taint. Therefore, the objective of the present study, conducted within a national project entitled BOARMARKET, is to know the prevalence of boar taint in Spanish entire male pig production by detecting androstenone and skatole levels in fat. The final aim is to provide objective information about this subject to the pig sector.

2. Material and methods

2.1. Animal and raising conditions

The study was carried out in pigs from commercial farms from 5 Spanish regions (Aragón, Catalonia, Castilla y León, Madrid/Castilla-La Mancha and Murcia). These regions were selected because they are the main pig producing areas in Spain, with 74.7% of the Spanish pig production (MAGRAMA, 2013), and the biggest pig exporters to European and Asian countries (DataComex, 2015). The genetic of the animals were commercial crossbreeds that will be described in the results section. Animals were raised from 30 kg life weight in fattening farms until the slaughtering weight (around 100 kg live weight), during 18 to 20 weeks. The animal density was 10 to 15 pigs/pen.

2.2. Fat sampling

A total of 903 samples of subcutaneous fat were collected in 5 Spanish regions (Aragón, Catalonia, Castilla y León, Madrid/Castilla-La Mancha and Murcia). For each region, samples of subcutaneous fat were obtained from 6 farms, which slaughtered their pigs in commercial abattoirs. A minimum of 30 fat samples was collected from each farm resulting in a minimum of 180 fat samples per region. The sample collected from each pig was taken from the dorsal neck region (referred to as back fat) on the left carcass side. It is important to note that the samples were taken from the cervical region close to the head, and consisted of a maximum area of 15 × 5 cm of skin plus attached fat, all the way down to the intersection with the meat. Samples were individually labelled, vacuum packed and stored at −20 °C before being sent in batches to IRTA. The following data were recorded for each pig: genetic crossbreed, hot carcass weight and mid-line subcutaneous fat thickness at level of the last rib, manually measured with a ruler.

2.3. Selection of samples by human nose methodology

In this study an olfactory scoring system using a soldering iron to heat the samples (Malmfors & Hansson, 1974; Whittington et al., 2011), referred to as human nose methodology (Mathur et al., 2012), was used to select the fat samples to be later analysed for androstenone and skatole levels by chemical analysis. For the various BOARMARKET project experiments, 3 trained assessors who are sensitive to androstenone, two women and one man, were selected and retrained for the sensory assessment of the fat samples using the method described in previous studies (Font i Furnols et al., 2000). In the present study the samples were classified in 2 categories according to the presence of boar taint. Therefore, samples scored as 'no boar taint' by the 3 panellists were classified as 'absence of boar taint'. The samples scored as 'boar taint' by at least one panellist were classified as 'presence of boar taint'. Detection limits of the panellists were 0.20 μg/g of adipose tissue for androstenone and 0.05 μg/g of adipose tissue for skatole, and were determined using decreasing concentrations of androstenone and skatole in sunflower oil (Font i Furnols et al., 2000).

2.4. Chemical analyses of androstenone and skatole

Samples classified as 'presence of boar taint' by human nose methodology were all analysed for androstenone and skatole by chromatographic techniques. In order to check human nose methodology, one sample per farm classified as 'absence of boar taint' was also analysed. The rest of the samples were considered to have concentrations in adipose tissue of androstenone and skatole of <0.20 μg/g and <0.05 μg/g, respectively. Androstenone analysis was performed using the gas chromatography–mass spectrometry (GC–MS) technique (Rius & García-Regueiro, 1998) and skatole and indole analysis by high-performance liquid chromatography (HPLC) (García-Regueiro & Rius, 1998). According to the results from the chemical analysis the samples were classified in different levels (Bonneau & Chevillon, 2012; Claus et al., 1994; Rhodes, 1971) for androstenone as follows: no androstenone <0.2 μg/g, low ≥0.2 to 0.5 μg/g, medium ≥0.5 to 1.0 μg/g and high ≥1.0 μg/g of adipose tissue; and for skatole: no skatole <0.05 μg/g, low ≥0.05 to 0.10 μg/g, medium ≥0.10 to 0.20 μg/g, high ≥0.20 μg/g of adipose tissue. In accordance with this classification, the meat obtained from carcasses with a medium or high concentration of androstenone or skatole can be considered to be an issue for some consumers, whilst low levels may be accepted (Font i Furnols et al., 2003).

2.5. Statistical analyses

The data were analysed using SAS 9.2 software (SAS Institute Inc., Cary, NC, USA). Differences between Spanish regions were studied using the mixed procedure of SAS. Spanish region was considered as fixed effect. Differences were adjusted with Tukey's test, and the significance level was fixed at $P < 0.05$.

3. Results

3.1. Carcass characteristics

A total of 903 back fat samples from entire male pigs were evaluated. Mean and standard error for hot carcass weight was 79.4 ± 8.19 kg, and

Table 1
Least square means and standard error (S.E.) of hot carcass weight and subcutaneous fat thickness measured at the last rib level per region.

Region	Hot carcass weight (kg)[1]	S.E.	Subcutaneous fat thickness (mm)[1, 2]	S.E.
Aragón	80.4[b]	0.56	18.7[a]	0.37
Catalonia	78.1[c]	0.56	16.6[b]	0.37
Castilla y León	85.3[a]	0.56	18.8[a]	0.37
Madrid/Castilla-La Mancha	77.5[cd]	0.56	19.3[a]	0.37
Murcia	75.5[d]	0.56	18.7[a]	0.37

[1] According to variation factor means with different superscripts are significantly different within one column $P < 0.05$.
[2] Mid-line subcutaneous fat thickness was measured at the last rib level.