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Evaluation of different strategies to mask boar taint in cooked sausage

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ABSTRACT

The use of smoking and/or spices was evaluated for their ability to mask boar taint in frankfurters manufactured from entire pigs with high levels of androstenone. Five frankfurter types were considered: control, smoked, flavouring + smoked, spicy and spicy + smoked. A trained panel in androstenone perception carried out a sensory profile on the different sausages. The highest scores for androstenone perception (odour, flavour and aftertaste) were found in frankfurters that included no masking strategy which indicated the effectiveness of the evaluated strategies. Regarding masking strategies, the contribution of spices and smoking to sensory perception of frankfurters was detected by the panellists. Smoking was the best strategy to mask androstenone odour, while the use of spices masked androstenone odour to a greater extent than androstenone flavour. Only the combined use of spices and smoking was able to eliminate the perception of androstenone. The application of this strategy in frankfurters could be an alternative in the commercialization of entire pigs.

1. Introduction

European changes in animal welfare regulations and policies, in particular regarding the pig sector, are the result of increasing societal pressure to seek more humane production systems (Kallas et al., 2015). In this context, the pork meat industry may in the future face a ban on castration of male piglets which could lead to a medium and high risk of boar taint. Boar taint is a distinctive and unpleasant taint perceived through a combination of sensory odour and flavour in pork and pork products during cooking and eating (EFSA, 2004). It is widely accepted that androstenone (a male sex pheromone associated with urine and perspiration odour) and skatole (a metabolite of the amino acid tryptophan associated with naphthalene and faecal odour) are mainly responsible for boar taint-related off-flavours in pork. Androstenone is non-polar and thus mostly fat soluble, whereas skatole is both water- and fat-soluble (Lundström, Matthews, & Haugen, 2009). Their concentrations, therefore, are dependent on the fat content of the muscle.

Approximately 99% of consumers are sensitive to skatole, but a variable percentage of consumers are anosmic to androstenone. According to Font-i-Furnols (2012) it may be reasonable to consider that approximately 55% of consumers are insensitive. Several studies have revealed that consumers with this specific anosmia can acquire the ability to perceive androstenone over time if they are frequently exposed to the substance (Mörlein, Meier-Dinkel, Moritz, Sharifi, & Knorr, 2013; Wysocki, Dorries, & Beauchamp, 1989). This could mean that more consumers will dislike male meat as a result of a castration ban (Lunde et al., 2012).

The literature suggests that the negative impact of boar taint in consumer acceptability would be less in processed pork than in fresh meat because processing may decrease the negative perception of androstenone and skatole. As both substances are volatile, their concentrations are reduced when the products are heat treated during cooking or processing (Dehnhard, Claus, Herbert, & Hillebrand, 1995). Considering that skatole has a higher volatility, it is assumed that androstenone makes a greater contribution to boar taint than skatole in cooked meat (Bañón, Costa, Gil, & Garrido, 2003a). Additionally, the temperature of consumption of processed products is particularly important: cold consumption minimises odour release while warm consumption encourages it. Lastly, recently Aaslyng, Broge, Brockhoff, and Christensen (2015) in cooked meat products (bacon and pork belly roll) where smoking or spices are used in the preparation, unpleasant odours or flavours can be masked. However, in products such as smoked cooked ham, streaky bacon and flank roll (prepared with a spice mixture), Tørngren, Claudi-Magnussen, Støier, and Kristensen (2011) and Tørngren, Kristensen, and Claudi-Magnussen (2012) found that the manufacturing process did not totally mask the boar taint, particularly in meat products from pigs with high levels of androstenone. In another study Font-i-Furnols (2012) reviewed consumer studies on the sensory acceptability of boar taint and observed that, for consumers, processing does not solve all the problems concerning boar taint.

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Few studies have been published on strategies to reduce boar taint in meat products. Plimpton, Ockerman, and Greene (1974) and Plimpton, Ockerman, Cahill, and Hilt (1976) evaluated the use of spices such as fennel and the level of boar pork in bologna and frankfurter. These authors, cited by Malmfors and Lundström (1983), stated that hot frankfurter sausages containing up to 50–70% strongly tainted boar meat were acceptable and that boar pork with a moderate taint level could possibly be used as the sole meat component of frankfurters. Lunde et al. (2008) evaluated different ingredients suitable for marinating entire male pork meat and indicated that common and strong food flavour additives like oregano extracts and liquid smoke affected the perception of boar taint. Stolzenbach, Lindahl, Lundström, Chen, and Byrne (2009) studied the use of smoking to remove the perception of boar taint in fermented sausages. The results of this study were not conclusive, but the authors indicated that smoke may present a potential solution to remove the perception of boar taint in fermented sausages if the smoking procedure is optimised.

Therefore, research is needed to propose processing recipes that will minimize the off-flavour caused by androstenone so that the processing industry can provide high sensory quality meat products. It is especially important in products with high fat content that are consumed hot, among them frankfurters, which are consumed worldwide because of their convenience. The purpose of this study was to evaluate different strategies for their ability to mask boar taint in frankfurters manufactured from pigs with high levels of androstenone.

2. Materials and methods

2.1. Experimental design

To mask boar taint in frankfurter manufactured from entire males with high androstenone levels, five types of frankfurter sausages were prepared: CO (control, prepared according to a standard recipe), SMO (standard recipe and smoking by sawdust), FL + SMO (standard recipe including a higher amount of commercial flavouring and smoking by sawdust), SPI (standard recipe and a spices and herbs mixture) and SPÌ + SMO (standard recipe and spices and herbs mixture and smoking by sawdust).

2.2. Raw material

The selection of entire pigs was based on the content of both androstenone and skatole in the neck fat. Entire males with high levels of boar taint were selected at Spanish slaughterhouses using the human nose methodology (Mathur et al., 2012; Borrisser-Pairó et al., 2016). Fat samples from the neck area were analysed for androstenone and skatole using GC–MS (Rius & García-Regueiro, 1998) and HPLC (García-Regueiro & Rius, 1998) methods, respectively. Thirteen carcasses with high androstenone (1.978 ± 0.529 μg/g fat) and low skatole (0.073 ± 0.039 μg/g fat) levels were purchased. From these, lean meat (from shoulder, belly and ham) and fat (from neck, belly and ham) were obtained for subsequent frankfurter manufacturing and randomly divided into batches in such a way that all batches included lean and fat from all selected pigs.

In each batch the meat and fat were cut into cubes (approximately 5 × 5 × 5 cm), vacuum packed separately and frozen at −20 °C. The lean meat was thawed at 4 °C for approximately 18 h before use whereas the fat was used frozen.

2.3. Frankfurter formulation and processing

The experimental frankfurters were prepared in a pilot plant according to industrial procedures. The standard recipe contained lean meat (50%), pork fat (25%), ice/water (25%), potato starch (2.5%), soybean protein (2%), sodium chloride (2%), kappa carrageenan (0.5%), sodium polyphosphate (0.3%), dextrose (0.25%), pork flavouring JBT-200 (0.2%), sodium ascorbate (0.05%) and sodium nitrite (150 ppm). In the case of the FL + SMO frankfurter a higher percentage of JBT-200 was used with respect to that used in the standard recipe (0.4 vs 0.2%, respectively). To manufacture SPI and SPI + SMO frankfurters spices and herbs were added to the standard recipe: 0.2% white pepper (*Piper nigrum* L.), 0.2% mustard seed (*Sinapsis alba*), 0.10% paprika (*Capsicum annum*), 0.05% nutmeg mace (*Myristica fragans*), 0.05% coriander seed (*Coriandrum sativum L.*), 0.05% small cardamom fruit (*Elettaria cardamun*) and 0.05% sweet marjoram herb (flowering plant of *Origanum majorana*). All additives, spices and herbs were provided by Proanda S.L. (Seville, Spain).

Two batches of each different type of frankfurter sausages were prepared. Meat, fat, ice, water, and other ingredients were emulsified by using a bowl cutter (CM-41, Mainca. Barcelona, Spain). The temperature of the emulsion was maintained below 8 °C during batter preparation. The batters obtained were vacuum stuffed (Tecmaq Microwat, Barcelona, Spain) into 20 mm collagen casings (NB300, Edicas, Ripoll, Spain) and linked every 130 mm, giving each sausage an approximate weight of 50 g.

The linked batters were processed in a cooking oven (Verinox Junior 1100, Vigolo Vattaro, Italy) using a four-stage cooking cycle: (1) 55 °C until the internal temperature of the product reached 33 °C, (2) 60 °C for 30 min, (3) 78 °C until the internal temperature of the product reached 72 °C and (4) 78 °C for 5 min. A thermocouple was placed in the centre of the samples to monitor and control the internal temperature. The smoking process (batches SMO, FL + SMO and SPI + SMO) was carried out using a smoke generator system fed by beech tree shavings during stage 2 of the cooking cycle.

After cooking, the frankfurters were cooled to 8 °C, kept in a refrigerated chamber (4 °C for 12 h), vacuum-packaged in polyamide/polyethylene with an oxygen transmission rate of $<40 cm^3/m^2/24$ h/1 atm and a water vaporization rate < 15 g/m^2/24 h (39 °C, 90% RH) supplied by Vacioplast Salamanca S.L. (Spain) and stored at 4 °C until the day of the analysis.

2.4. Physical and chemical analyses

2.4.1. Proximate analysis

Moisture content of the different types of frankfurter sausages was determined by drying following the ISO 1442:1997 method (ISO 1442, 1997). Fat content was evaluated by Sohxlet extraction with diethyl ether according to the ISO method 1443:1973 (ISO 1443, 1973). Protein was measured using the AOAC official method 990.03 (2000), the Dumas nitrogen combustion method, using a Leco TruSpec Nitrogen Determinator (LECO INSTRUMENTOS, S.A. MADRID).

All determinations were performed in triplicate.

2.4.2. Analysis for boar taint compounds

Androstenone analysis was performed using the gas chromatography–mass spectrometry technique (Rius & García-Regueiro, 1998) and skatole analysis by high-performance liquid chromatography (García-Regueiro & Rius, 1998).

2.5. Sensory evaluation

The five types of frankfurter sausages were sensory analysed by a trained sensory panel. The panel consisted of ten panellists with long experience in sensory profiling in meat and meat products. The panellists were all sensitive to androstenone and skatole in pure form and had participated in training for sensory evaluation of meat and meat products from entire male pigs (Garrido et al., 2015).

The samples were evaluated in a standardized sensory room designed according to ISO 8589 (2007) guidelines with a separate booth using red light to mask colour differences. Each panellist evaluated 6 samples per type of frankfurter.