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Boar taint detection: A comparison of three sensory protocols

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ABSTRACT

While recent studies state an important role of human sensory methods for daily routine control of so-called boar taint, the evaluation of different heating methods is still incomplete. This study investigated three common heating methods (microwave (MW), hot-water (HW), hot-iron (HI)) for boar fat evaluation. The comparison was carried out on 72 samples with a 10-person sensory panel. The heating method significantly affected the probability of a deviant rating. Compared to an assumed 'gold standard' (chemical analysis), the performance was best for HI when both sensitivity and specificity were considered. The results show the superiority of the panel result compared to individual assessors. However, the consistency of the individual sensory ratings was not significantly different between MW, HW, and HI. The three protocols showed only fair to moderate agreement. Concluding from the present results, the hot-iron method appears to be advantageous for boar taint evaluation as compared to microwave and hot-water.

1. Introduction

Consumer researchers are well aware of the quality of products. The food industry constantly faces the demand to maintain both quality and profitability simultaneously. Quality, however, is an elusive concept and as such must be operationalized and measured in order for it to be maintained Moskowitz (1995).

As any other industry, the meat industry faces the requirement to maintain quality and at the same time meet consumer demands. In the European Union (EU), the situation for the pig meat industry is changing as the production system is under public debate. One example is the welfare issue of the surgical castration of male piglets without pain reducing means. In the light of consumer concerns there is widespread and growing interest in the production of high animal welfare products. Consequently, European pork production stakeholders called for a ban of this practice in 2010 (European Declaration on alternatives to surgical castration of pigs, 2010). As a result, the castration without anesthesia will be prohibited by law by 2019 in Germany (Tierschutzgesetz, 2013). Therefore the production of so-called entire male pigs could be one viable alternative and thus has been constantly investigated. Among others there were and are EU-projects investigating various aspects of the production of entire male pigs. For instance, the EU research program AIR (3-PL94-2482) investigated the importance of androstenone and skatole for human sensory perception (Bonneau, Lundstrom, & Malmfors, 1997).

Currently no rapid technical method is available for routine analyses of boar taint in or at the slaughterline (Haugen, Brunius, & Zamaratskaia, 2012). To maintain impeccable quality and to meet consumer needs, at the moment the sensory evaluation of boar carcasses is performed in-line or at-line by trained assessors (Mathur et al., 2012). The sensory quality control system for boar taint is challenging: on the one hand, EU regulations require that meat must be declared unfit for human consumption if organoleptic anomalies, such as sexual odor, occur (Regulation EC No 854/2004, 2004); on the other hand, rapid sensory quality tests are usually under tight time constraints with implicit compromises in sensory practices (Lawless & Heymann, 2010). In conclusion, at the moment the sensory evaluation of boar carcasses is a necessary quality control instrument which should fulfill both quality control and assurance, as well as meeting consumer expectations and guaranteeing marketplace success.

To understand consumer expectations, it is important to know that the human olfactory memory supports us in reacting to unexpected odors that do not fit our memory based expectations (Köster, Møller and Mojet, 2014). Such unexpected odors could be androstenone and skatole in pork products which are related to the occurrence of boar taint (Lunde, Skuterud, Hersleth, & Egelandsdal, 2010; Patterson,

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1968; Vold, 1970). Köster and colleagues explain that human detection of food properties is based on detection of change rather than on recollection of previous experience with the food (Köster et al., 2014). As early as 1991, Nijssen assumed that people are extremely sensitive to off-odors and off-flavors even in complex odor mixtures (Nijssen, 1991). Although psychological effects, as the top-down process, are described as influencing the liking or disliking of a food product through individual beliefs, experiences, expectations and associations (Lee, Frederick, & Ariely, 2006), the perception of odors is emotional (Herz, 2004; Herz & Schooler, 2002). Therefore, off-odors may outweigh the positive top-down effect of the animal welfare aspect of boar meat.

Since androstenone and skatole are predominantly released when fat is heated (De Kock, Heinze, Potgieter, Dijksterhuis, & Minnaar, 2001) the sensory evaluation is carried out using heating methods. Up to date, several studies have evaluated different heating methods for boar taint detection. For instance, in 2011 Whittington and colleagues analyzed five heating methods (microwave at 60 °C, hotwire at 180 °C, boiling method and subsequently cooling to 75 °C or 25 °C, and melting with a surface temperature of 185 °C) on 120 samples by three assessors using an 8-point scale (1 = extremely weak to 8 = extremely strong) for pork odor intensity and abnormal odor intensity (Whittington et al., 2011). Bekaert and colleagues compared three methods (microwave, soldering iron and pyropen) on 83 samples evaluated by four assessors on a visual analogue scale with anchor points (0 = normal pork smell to 4 = strong boar taint) for scoring boar taint intensity (Bekaert et al., 2013). The authors conclude that all methods are suitable for boar taint detecting but the choice of the heating method depends on habituation of the trained assessor. The mentioned method comparison studies lack in the number of assessors.

The major source of variability in sensory tests is the measuring instruments itself, namely the human tester (Lawless & Heymann, 2010); and the physiological processes of sensory perception help us to understand the limits of sensory function and how sensations interact (Lundström, Boesveldt, & Albrecht, 2011; Lundström et al., 2012). The ISO 8586 sensory analysis guidance recommends at least 10 selected assessors in a sensory panel (DIN EN ISO, 2012), a recommendation which was not met by the studies mentioned above. This is a necessary step to conclude which method performs best in general. The methods must be studied to determine their precision and accuracy in order to judge their suitability for daily routine analysis. Previous studies suggested various tools to assess the sensory performance, e.g., Xue, Dial, and Morrison (1996) and Meier-Dinkel, Gertheiss, Müller, Wesoly, and Mörlein (2015).

In this study, we analyzed three commonly used protocols to heat fat samples for boar taint detection, i.e., the microwave (MW), the hot-iron (HI) and the hot-water (HW) method using a sensory panel consisting of 10 assessors (ISO 8586). (1) To answer the question as to what extent each method corresponds with a chemical analysis (reference) a risk analysis according to Meier-Dinkel et al. (2015) was conducted. Variance in analytical chemistry is a known fact. To improve the reliability of each chemical result, analyses were done in duplicate, and means were used for further calculations. (2) Logistic regression models were used to investigate the effects of each method and the concentrations of both androstenone and skatole on the probability of deviant ratings. (3) To evaluate the consistency of the scores given by the panel for the same sample, intraclass correlations (ICC) were calculated. (4) Finally, to assess the agreement between the methods as well as between the panelists Cohen's Kappa coefficients were computed.

2. Materials and methods

The sensory evaluation was conducted on six testing days over a three week period in the Laboratory for Sensory Analysis and Consumer Research at the University of Göttingen. The laboratory, which is built according to the ISO 8589:2010 norm, has 10 individual booths and a ventilation system which exchanges air at a rate of six times per hour. The experiments were conducted under daylight.

2.1. Sensory panel

The sensory panel consisted of 10 assessors. All assessors were selected on the basis of their individual olfactory performance (Meier-Dinkel et al., 2013; Trautmann, Gertheiss, Wicke, & Mörlein, 2014) and then trained for boar fat evaluation using the MW method for a period of 2 months up to 2.5 years. Their detection thresholds were measured at the beginning of the study using sniffing strips with 20 binary dilution levels of androstenone and skatole. The assessors mean detection threshold for androstenone was level 10.1 ± 2.2 standard deviation (SD) (level 10 corresponds to about 0.005 μg androstenone on the strip) and level 8.8 ± 1.4 (level 9 corresponds to about 0.005 μg skatole on the strip) for skatole. Since the assessors were trained to apply the MW method, it was also necessary to familiarize them with the HW and HI methods. This training was divided into four sessions comprising a total of 10 h.

2.2. Calibration procedure for the sensory quality control

To ensure that the panelists were aware of the intensity scale points, each session began by establishing references using smell strips (Meier-Dinkel et al., 2013; Trautmann et al., 2014). According to Meier-Dinkel et al. (2015) concentration level 6 (~0.09 μg androstenone or 0.04 μg skatole on the strips) was used for the scale point 2 ("slight deviation from standard") and concentration level 4 (~0.34 μg androstenone or 0.16 μg skatole) for the scale point 4 ("strong deviation from standard"). A similar calibration routine was followed for fat evaluation. As the panelists were accustomed to the MW method, this was the method of choice for routine calibration. They received boar samples labeled "standard" and "deviant". Fat samples presented as "standard" contained ≤0.69 μg/g androstenone (mean = 0.33 μg/g) and ≤0.1 μg/g skatole (mean = 0.06 μg/g). Fat samples labeled as "deviant" contained up to 5.58 μg/g androstenone (mean = 3.46 μg/g) and up to 0.37 μg/g skatole (mean = 0.26 μg/g) (Fig. 1).

2.3. Study design

Once the calibration procedures were completed, the actual experiment began in which all three different heating methods were used (MW, HW, HI). On every testing day 12 randomly selected samples were assessed using each method producing a total of 36 samples per testing day. In the course of the experiment, 72 samples were assessed by each method, so that every assessor evaluated 216 samples in total.

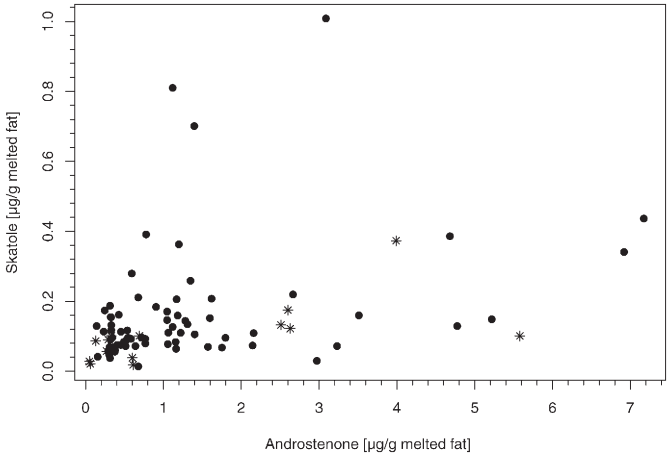

Fig. 1. Androstenone and skatole concentrations in μg/g melted neck fat. Dots represent the 72 samples for the study. Asterisks define the samples for training of the sensory panel.