Food Research International 67 (2015) 390–399

Contents lists available at ScienceDirect

Food Research International

journal homepage: www.elsevier.com/locate/foodres

Effects of context and repeated exposure on food liking: The case of boar taint

Daniel Mörlein [a,*,1], Christian Schiermann [a], Lisa Meier-Dinkel [a], Johanna Trautmann [a], Ruth Wigger [a], Gerhard Buttinger [b], Michael Wicke [a]

[a] University of Göttingen, Department of Animal Science, D-37075 Göttingen, Germany
[b] European Commission, Joint Research Centre, Institute for Reference Materials and Measurements (JRC IRMM), B-2440 Geel, Belgium

ARTICLE INFO

Article history:
Received 19 September 2014
Accepted 23 November 2014
Available online 1 December 2014

Keywords:
Boar taint
Consumer acceptance
Home use test
Androstenone
Skatole
Repeated exposure

ABSTRACT

This study investigated whether consumer acceptance of boar meat is overestimated by standardised situational testing and whether repeated exposure decreases liking. Thus, a home use test (HUT) followed by a central location test (CLT) was conducted to assess the acceptance of minced boar meat with approximately 14% fat either HIGH or LOW in androstenone (2.0 vs. 0.30 ppm) and skatole (0.30 vs. 0.06 ppm) in comparison to meat from castrates and gilts (CONTROL). In HUT, no significant difference ($p > .05$) in dislike frequency was observed between CONTROL and LOW. For HIGH, liking was strongly impaired during frying. The results indicated a masking effect of the ready-made sauce on the odour but not on the flavour. In CLT, dissatisfaction was generally higher than in HUT. Similar to HUT, HIGH boar meat was more often disliked ($p < .001$) compared to LOW and CONTROL in the CLT. To conclude, standardised testing did not underestimate acceptance. In contrast to anticipations, a single previous exposure to boar meat with high levels of androstenone and skatole did not affect ($p > .05$) liking in the follow-up CLT.

1. Introduction

In the European Union, pork production stakeholders have declared to ban surgical castration by 2018 for animal welfare reasons (Declaration of Brussels, 2011) which has posed a challenge to all stakeholders involved in the pork production chain. The alternatives currently discussed to replace non-anaesthetised castration include surgical alternatives, i.e. castration under general anaesthesia, local anaesthesia and pain treatment, and non-surgical alternatives, i.e., immunocastration and raising entire males (Von Borell et al., 2009).

Raising intact male pigs has some economic advantages as boars possess the advantage of superior growth over castrates, a lower feeding demand, more efficient feed conversion to live-weight and generally leaner carcasses (Lundström, Matthews, & Haugen, 2009). However, the occurrence of so called boar taint may result in impaired consumer acceptance of pork (Lundström et al., 2009) This is an off-odour in pork that has been shown to be mainly due to accumulation of androstenone (Patterson, 1968) and skatole (Vold, 1970) in entire male pigs when they reach sexual maturity. Hence, raising boars is regarded as one viable alternative provided that tainted carcasses are reliably detected at slaughter. The ante mortem reduction of responsible compounds by means of breeding, husbandry, and feeding is considered equally important. The question remains, however, above what levels of boar taint compounds consumer acceptance is at risk. Since 1970, more than 500 studies on "boar taint" have been published in three major waves (early 1980s, mid-1990s/early 2000), and recently after the declaration of Brussels (www.webofknowledge.com). It has repeatedly been shown that elevated levels of androstenone and skatole result in impaired consumer acceptance of pork and pork products (Babol, Squires, & Gullett, 2002; Bañón, Andreu, Laencina, & Garrido, 2004; Bonneau & Chevillon, 2012; Font i Furnols, 2012; Lunde, Skuterud, Hersleth, & Egelandsdal, 2010; Malmfors & Lundström, 1983; Meier-Dinkel et al., 2013; Walstra et al., 1999). It must be noted, however, that the comparison between studies and subsequently the estimation of thresholds for consumer acceptance is impeded by considerably biased protocols for analytical quantification of boar taint compounds (Ampuero Kragten et al., 2011). On the other hand, it has been shown that the agreement of chemical analysis with sensory evaluation is moderate. Furthermore, human olfactory acuity to androstenone has been identified being a key factor in understanding the perception of boar meat (Mathur et al., 2012; Meier-Dinkel, Gertheiss, Müller, Wesoly, & Mörlein, 2015; Xue, Dial, & Morrison, 1996).

* Corresponding author at: University of Göttingen, Department of Animal Sciences, Albrecht-Thaer-Weg 3, D-37075 Göttingen, Germany. Tel.: +49 551 39 5611; fax: +49 551 39 5587.
E-mail addresses: daniel.moerlein@agr.uni-goettingen.de, daniel.moerlein@isi-goettingen.de (D. Mörlein).
[1] present address: isi GmbH & Co. KG, D-37124 Rosdorf (Göttingen), Germany.

http://dx.doi.org/10.1016/j.foodres.2014.11.037
0963-9969/

Overlooking this large number of studies identified several knowledge gaps that should be addressed here, i.e. home use testing, the use of fresh instead of frozen meat, and using meat with increased fat levels. A comprehensive review on previous sensory studies using boar meat (Font i Furnols, 2012) showed that usually standardised situational tests such as central location tests (CLTs) were performed where the meat is prepared by the experimenters and then served to the consumers. Standardising the cooking and serving has advantages in regard to increased internal validity. However, one is at risk that a large proportion of the volatile boar taint compounds disappear during the cooking procedure, i.e. before the meat is served. For example, in a recent study where consumers were asked to evaluate the odour above the frying pan, liking of meat patties spiked with androstenone was significantly lower compared to control samples (Lunde et al., 2010). Liking was not significantly different, however, when the consumers were absent from cooking, i.e., when the fried meat was served in the booths (Lunde et al., 2010). It is therefore to be expected that results from CLTs may underestimate the risk of reduced acceptance when consumers are not involved in the cooking procedure (Bonneau & Chevillon, 2012; Meier-Dinkel, Sharifi, et al., 2013; Meier-Dinkel, Trautmann, et al., 2013). It appears to be disadvantageous, however, to use meat spiked with synthetic androstenone and skatole as this does not necessarily represent the natural fat composition of boars which may contain other substances also contributing to odour and flavour (Fischer et al., 2014; Rius, Hortos, & Garcia-Regueiro, 2005) As the compounds are lipophilic, the absolute amount of the malodorous compounds increases with increasing fat content. In addition, most (if not all) of the previous consumer studies used frozen meat.

A more realistic situation is to measure consumer attitudes under usual circumstances at home. This combines two benefits. First, different foods are usually combined in a meal and, second, it gives the results real-life (external) validity. Here, we aim to combine the benefits of a home use study presenting fatty meat that has neither been frozen nor reheated, and the assessment of the individual androstenone sensitivity of consumers, as a specific anosmia was demonstrated (Amoore, Pelosi, & Forrester, 1977; Havlicek, Murray, Saxton, & Roberts, 2010). Moreover, the exposure history of consumers needs to be considered too, as repeated exposure was shown to induce or increase sensitivity to androstenone (Mörlein, Meier-Dinkel, Moritz, Sharifi, & Knorr, 2013; Wysocki, Dorries, & Beauchamp, 1989). To the best of our knowledge, there have not yet been any studies concerning the question whether repeated exposure to boar tainted meat affects consumer acceptance of pork.

Furthermore, most of the previous consumer studies have been using very lean meat such as loin (Font i Furnols, 2012) which has, on average, about 2% intramuscular fat while boars being even lower, which increases the risk of undesired changes to meat quality. For example, the higher amount of polyunsaturated fatty acids (PUFA) in fat tissue from boars compared to barrows and castrates (Mackay, Pearce, Thevasagayam, & Doran, 2013; Pauly, Spring, Doherty, Kragten, & Bee, 2009) is likely to increase fat oxidation during storage. Furthermore, when re-heated meat is used for consumer tests (Matthews et al., 2000), the development of a warmed-over flavour (Byrne et al., 2001) probably further increases consumer dislike compared to meat from castrates.

Specifically, this study sought

i. to evaluate consumer acceptance of fresh (unfrozen) boar meat with elevated fat content during preparation and eating at home (home use test, HUT; study 1),
ii. to assess consumers' olfactory acuity to androstenone and their appreciation of it, and to relate their sensitivity to meat liking,
iii. to study the liking of the (same) meat under standardised laboratory conditions (central location test, CLT; study 2), and
iv. to evaluate whether previous exposure to tainted boar meat impacts on meat liking.

2. Subjects, material & methods

2.1. Study 1 (home use test)

2.1.1. Carcass selection and preparation of minced meat batches

In contrast to previous consumer studies, freeze-thawing of the meat was avoided by presenting chilled meat within three days after slaughter: At a commercial slaughter house, 40 boar carcasses were pre-selected from the daily routine production by means of sensory evaluation, i.e., a single assessor indicatively evaluated boar taint in the slaughter line by shortly (about 2 s) heating intramuscular fat at the neck with a heat gun set at approximately 550 °C. Upon subsequent confirmation whether or not the odour of androstenone and/or skatole was present by a second assessor off-line using approximately 10 g of neck fat heated in a glass containers, back fat samples from pre-selected carcasses were put in HDPE bags, stored on ice and transported to the laboratory for immediate analysis of boar taint compounds ($UGOE_{2011}$, see Section 2.1.2).

Based on the sensory evaluation and the immediate chemical analysis, 7 carcasses each were assigned to two batches of boars either LOW or HIGH in malodorous compounds. For a control batch (CONTROL) carcasses of barrows and gilts were randomly taken from the daily production. After about 48 h post-mortem carcasses were dissected to produce three batches of minced meat: Shoulders were deboned and then coarsely ground and further mixed in large stainless steel containers. The batches were then filled into a rotary screw mincer linked to a filling line for fine-grinding and subsequent filling and sealing of the packs using a fully automatic line. During mixing, fat content was predicted using a near infrared spectrometer (Meat Check, Foss AB Sweden). As the shoulder appeared to be leaner than expected, about 10 kg of deskinned back fat of the selected carcasses was added to each batch. It was initially intended to achieve a fat content of about 18% as minced pork is usually sold in Germany. By contrast, in other countries fat levels are as low as 15% (The Netherlands) or as high as 25% (Poland).

Fat content of three packs per batch was later confirmed to be 16.4% (CONTROL), 13.0% (LOW) and 13.9% (HIGH) using petroleum benzine extraction according to German Food legislation protocols (LFGB §64, 2013). Meat was sealed in retail containers (300 g each) using modified atmosphere (80% oxygen, 20% carbon dioxide) and labelled for commercial use, i.e. with brand name, weight, best-before-date etc.

2.1.2. Chemical analysis of boar taint compounds

2.1.2.1. Immediate analysis for carcass selection ($UGOE_{2011}$). Within 48 h, boar taint compounds were determined using GC–MS for androstenone and HPLC for skatole as described previously (Mörlein, Grave, Sharifi, Bücking, & Wicke, 2012).

2.1.2.2. Method comparison ($UGOE_{2014}$, JRC_{2014}). Aliquots of the back fat samples were kept frozen at −20 °C until 06/2014 and were re-analysed both at the European Commission, Joint Research Centre, Institute for Reference Materials and Measurements (JRC IRMM, Geel, Belgium) (JRC_{2014}) (Buttinger, Karasek, Verlinde, & Wenzl, 2014) and at the University of Göttingen in 2014 ($UGOE_{2014}$) using deuterium labelled boar taint standards that had not been available at the time the study was conducted. This method comparison was deemed necessary as large inter-laboratory bias on androstenone analysis was reported lately.

The method of the European Commission was developed with the aim of introducing a standardised reference method for the analyses of androstenone, skatole and indole in pork fat samples and will be submitted to ISO for standardisation. Therefore it is described here in brief. The back fat sample is cleaned from any other tissue like the skin, muscle or visceral fat so that only the subcutaneous fat tissue remains. The frozen tissue is blended and thereafter the fat is separated from the tissue via melting. An aliquot of the fat that is spiked with isotope labelled