



# Impact of consumer's sensitivity to androstenone on acceptability of meat from entire male pigs in three European countries: France, Spain and United Kingdom<sup>☆</sup>

M. Blanch<sup>a</sup>, N. Panella-Riera<sup>a,\*</sup>, P. Chevillon<sup>b</sup>, M. Font i Furnols<sup>a</sup>, M. Gil<sup>a</sup>, J.M. Gil<sup>c</sup>, Z. Kallas<sup>c</sup>, M.A. Oliver<sup>a</sup>

<sup>a</sup> IRTA-Monells, Finca Camps i Armet, 17121 Monells, Spain

<sup>b</sup> IFIP, La Motte au Vicomte, 35651 Le Rheu, France

<sup>c</sup> CREDA, Parc Mediterrani de la Tecnologia, 08860 Castelldefels, Spain

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## ABSTRACT

The aim of this work was to study consumers' acceptance of pork with different levels of boar taint according to their androstenone (AND) sensitivity in France (FR, N = 144), Spain (ES, N = 101) and United Kingdom (UK, N = 147). Samples were classified as 'females', 'detection minus' males (low levels of AND and skatole – SKA) and 'detection plus' males (high levels of AND and SKA). Globally, 22.7% of consumers were high sensitive, 28.3% middle and 49.0% low sensitive or insensitive to AND. Sixty-five percent dislike AND odour. AND disliking was lower in UK than ES and FR. The percentage of consumers that may reject tainted meat was 14.3–41.0%; the risk was lower in UK than ES and FR. The description of AND odour varied according to the degree of sensitivity of the consumers. High AND levels reduced the acceptability of boar meat; medium AND levels could even improve its acceptability compared with low levels, resulting in meat which is as positive as that from females.

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## 1. Introduction

Boar taint is an unpleasant off-odour and off-flavour of pork from some entire male pigs characterised as urine-like, pig-like, sweat-like or faecal-like, which may result in consumer dissatisfaction (Annor-Frempong, Nute, Whittington, & Wood, 1997a, 1997b; Dijksterhuis et al., 2000; Lunde, Skuterud, Nilsen, & Egeland, 2009). The main compounds responsible for boar taint are androstenone (AND; Patterson, 1968) and skatole (SKA; Vold, 1970; Walstra & Maarse, 1970) which are accumulated in the fat tissue.

Many studies have reported the influence of the sex of pigs and the levels of AND or SKA on the acceptability of pork by consumers. Some authors showed no differences in the acceptability of meat between entire male and female or castrates (Ciplef, Grinwich, & Castell, 1984; Kempster, Dilworth, Evans, & Fisher, 1986; Nold, Romans, Costello, Henson, & Libal, 1997; Rhodes, 1972). However in other studies the acceptability differed depending on the sex of the animal and/or the levels of boar taint (Diestre, Oliver, Gispert, Arpa, & Arnau, 1990; Font i Furnols et al., 2008; Matthews et al., 2000). Besides, people react very differently to boar taint, depending on the country of origin, gender, age and their sensitivity (Font i Furnols, Gispert, Diestre, & Oliver, 2003; Font i Furnols, Guerrero, Serra, Rius, & Oliver, 2000; Matthews et al., 2000; Weiler et al., 2000). Almost all the consumers are sensitive to SKA, whereas some people are anosmic

for AND. The perception of AND is determined genetically (*ORD7D4* genotype; Keller, Zhuang, Chi, Vosshall, & Matsunami, 2007) and, generally, women are more sensitive than men. Depending on the geographic region, the percentage of anosmic women has been reported to be 11–66% compared with 18–74% for men (Bekaert et al., 2010; Bremner, Mainland, Khan, & Sobel, 2003; Font i Furnols et al., 2003; Gilbert & Wysocki, 1987; Lunde et al., 2009; Weiler et al., 2000). Moreover, not only the sensitivity to AND differs between individuals, but also the liking. About 8% (3.3% women and 16.2% men) of highly sensitive consumers liked the odour of AND (Font i Furnols et al., 2003).

The most common method to avoid boar taint is castration. In most of the European countries castration is performed on 80–100% of the male pigs in conventional production, and surgical castration without anaesthesia is the most common technique (Fredriksen et al., 2009). The exceptions are United Kingdom and Ireland where castration is hardly performed, and some of the southern countries (Cyprus, Portugal and Spain) where a limited percentage of the male pigs are castrated. Moreover, nowadays there is a growing concern about the negative effect of surgical castration of pigs without anaesthesia on animal welfare. Norway and Switzerland have already banned this practice by law, and other countries such as The Netherlands and Germany have signed letters of intent (Declaration of Noordwijk 2007 and Düsseldorf Declaration 2008, respectively) which aim to avoid the need for piglet castration in the long term. Consequently, entire male production is one of the alternatives. Therefore, it would be interesting to study the impact that meat from boars could have in the European market (Consumer satisfaction), which is traditionally used to eating meat from castrated pigs.

<sup>☆</sup> The first and the second authors had an equal input to the paper.

\* Corresponding author. Tel.: +34 972630052; fax: +34 972630373.

E-mail address: [nuria.panella@irta.cat](mailto:nuria.panella@irta.cat) (N. Panella-Riera).

The present work had two main objectives: 1) to evaluate and update the results on sensory acceptability of meat from entire male pigs (as an alternative to the production of castrates), involving three European countries that produce different proportion of castrated pigs: France (97.5%), Spain (33.2%) and United Kingdom (2.1%), and 2) to assess consumers' sensitivity to AND (including the liking of AND smell and the risk to reject tainted meat).

## 2. Materials and methods

### 2.1. Classification of consumers

A total of 392 consumers from three different European countries were included in this study: France (FR, N = 144; performed in Caen and Paris), Spain (ES, N = 101; performed in Barcelona), and United Kingdom (UK, N = 147, performed in Reading). These consumers were stratified by age (according to each country profile) and sex (approximately 50:50 ratio between men and women), and were required to eat pork on a regular basis.

Consumers were checked for AND sensitivity after they had assessed the meat samples, by smelling crystals of pure substance following the protocol described by Weiler et al. (2000) with some modifications. Consumers were asked about their capability to smell AND (No: 'Insensitive'; Yes: 'Sensitive') and the odour intensity on an eight-point intensity scale (from 1 = 'extremely weak' to 8 = 'extremely strong'), the preference (I like/Neutral or I don't like), and about descriptors of the odour. Consumers were classified as 'Insensitive', 'Low sensitive' (1–3), 'Middle sensitive' (4–6) or 'High sensitive' (7–8). Furthermore, the percentage of consumers that might be more inclined to reject meat exhibiting AND-related boar taint was calculated, considering those who were simultaneously sensitive to AND and disliked its smell.

### 2.2. Meat sampling and preparation

The meat used for the sensory evaluation was obtained from conventional pig crossbreeds of each country. Samples from boars and gilts were collected in commercial Spanish and French abattoirs. The meat used for the sensory evaluation was taken from the *Longissimus dorsi* muscle of commercial entire pigs and females chosen according to the concentrations of AND and SKA in the subcutaneous fat. The determination of SKA levels was performed using HPLC-FLD and the determination of AND levels using GC-MS (ES and UK samples, Ampuero et al., 2011) or by HPLC-FLD (FR samples, Pauly, Spring,

O'Doherty, Ampuero Kragten, & Bee, 2008). AND concentration was expressed in µg/g, on pure fat basis. Meat samples were classified in three groups depending on the sex and the levels of boar taint compounds:

- females (Fe: females),
- 'detection minus' males (Det–: boars with low AND (<0.5 ppm) and SKA (<0.1 ppm) levels), and
- 'detection plus' males (Det+: boars with medium-high AND (>0.5 ppm) and/or SKA (>0.1 ppm), assuming that if AND was less than 1 ppm, SKA was higher than 0.1 ppm).

The concentration of AND and SKA in the samples used per group and country is described in Table 1 and Table 2 (FR and ES/UK, respectively).

For the consumer tests (carried out in ES, FR and UK), loins were cut into 0.5 cm thick slices with 5 mm of subcutaneous fat (when it was possible). Each slice was divided in two pieces, and cooked using a cooking plate at 180 °C (which was treated with maize oil). The meat was turned upside down regularly until a core temperature of 80 °C and the meat was salted after cooking, reproducing home preparation.

### 2.3. Sensory evaluation of samples

Sessions of 10–12 consumers were organised for meat evaluation as a Hall test. Each consumer assessed 3 pieces of meat, one from each type of animal (Fe, Det– and Det+). The order of presentation of samples was rotated using a partial Latin square design to avoid any first sample and carry-over effect and the identity of the samples was not given to consumers (Macfie, Bratchell, Greenhoff, & Vallis, 1989). Consumers assessed various quality aspects of meat related to acceptability using a modified nine-point intensity scale (from 1 to 9). The intermediate level (5) was not included to stimulate consumers to commit themselves and not to allow the easiest response (Guerrero, 1999). The attributes 'Delicious', 'Odour' and 'Taste' were rated on a scale going from 1 = 'dislike very much' to 9 = 'like very much' (avoiding level 5), whereas the attributes 'Strength of odour', 'Abnormal odour', and 'Abnormal taste' were scored between 1 = 'low perception' to 9 = 'strong perception' (avoiding intermediate level).

### 2.4. Statistical analysis

Data analyses were conducted using SAS Statistical Package (SAS Inst., Inc., Cary, NC, USA, version 9.2). To analyse the parameters

**Table 1**

Least square means for meat sensorial attributes assessed by French consumers depending on type of animal and consumer sensitivity to androstenone (insensitive or low, medium, high).

	Type of meat <sup>1</sup>			SEM	P-value <sup>2</sup>		
	Fe	Det–	Det+		Type	Sensitivity <sup>3</sup>	Type * Sensitivity
Androstenone (µg/g pure fat)	<0.2	<0.2	2.39 ± 1.07 (0.59–5.18)				
Skatole (µg/g pure fat)	<0.03	<0.03	0.11 ± 0.07 (0.02–0.28)				
Delicious	5.77	5.82	5.56	0.135	0.27	0.73	–
Odour	5.87 <sup>a</sup>	6.09 <sup>a</sup>	5.26 <sup>b</sup>	0.139	<b>&lt;0.001</b>	0.31	–
Taste	5.72	5.81	5.41	0.145	0.08	0.83	–
Strength of odour					0.43	0.06	<b>0.02</b>
Low sensitive	4.50	4.47	4.27 <sup>y</sup>	0.324			
Medium sensitive	4.07	4.25	4.02 <sup>y</sup>	0.454			
High sensitive	4.66 <sup>b</sup>	4.32 <sup>b</sup>	5.39 <sup>x,a</sup>	0.514			
Abnormal odour					<b>0.009</b>	<b>0.02</b>	<b>0.002</b>
Low sensitive	2.00	2.02	2.03 <sup>y</sup>	0.261			
Medium sensitive	2.16	2.20	2.18 <sup>y</sup>	0.310			
High sensitive	2.47 <sup>b</sup>	1.97 <sup>b</sup>	3.55 <sup>x,a</sup>	0.333			
Abnormal taste	2.20	2.21	2.49	0.148	0.20	0.10	–

<sup>1</sup>Fe: female meat, Det–: boar meat with low concentration of boar taint compounds, Det+: boar meat with boar taint.

<sup>2</sup>Significant P-values (P<0.05) are shown in bold.

<sup>3</sup>Means of sensitivity are not included in the table because no relevant differences were observed.

<sup>a,b</sup>Within a line, means without a common superscript letter differ (P<0.05).

<sup>x,y</sup>Within a column, means without a common superscript letter differ (P<0.05).

**Table 2**  
Least square means for meat sensorial attributes assessed by Spanish and British consumers depending on type of animal and consumer sensitivity to androstenone (insensitive or low, medium, high).

	Type of meat <sup>1</sup>			SEM	P-value <sup>2</sup>		
	Fe	Det–	Det+		Type	Sensitivity <sup>3</sup>	Type*Sensitivity
Androstenone (µg/g pure fat)	<0.04	0.20 ± 0.07 (0.04–0.29)	1.07 ± 0.40 (0.58–2.28)				
Skatole (µg/g pure fat)	0.04 ± 0.018 (0.02–0.07)	0.06 ± 0.02 (0.02–0.08)	0.18 ± 0.07 (0.11–0.39)				
Spain							
Delicious	6.68	6.49	6.91	0.171	0.09	0.47	–
Odour	6.66 <sup>ab</sup>	6.40 <sup>b</sup>	7.00 <sup>a</sup>	0.167	<b>0.006</b>	0.77	–
Taste	6.75	6.44	6.86	0.167	0.05	0.79	–
Strength of odour	5.44	5.07	5.36	0.209	0.27	0.92	–
Abnormal odour	2.49	2.53	2.23	0.217	0.32	0.94	–
Abnormal taste	2.33	2.49	2.29	0.205	0.56	0.94	–
United Kingdom							
Delicious	6.05 <sup>a</sup>	5.50 <sup>b</sup>	5.88 <sup>ab</sup>	0.175	<b>0.04</b>	0.65	–
Odour	6.28	5.84	6.14	0.155	0.06	0.33	–
Taste	6.29 <sup>a</sup>	5.75 <sup>b</sup>	6.24 <sup>ab</sup>	0.171	<b>0.02</b>	0.75	–
Strength of odour	4.27 <sup>a</sup>	3.75 <sup>b</sup>	4.26 <sup>a</sup>	0.166	<b>0.004</b>	0.39	–
Abnormal odour	2.81	2.79	2.87	0.154	0.86	0.83	–
Abnormal taste	2.89	2.78	3.08	0.151	0.18	0.56	–

<sup>1</sup>Fe: female meat, Det–: boar meat with low concentration of boar taint compounds, Det+: boar meat with boar taint.

<sup>2</sup>Significant P-values (P<0.05) are shown in bold.

<sup>3</sup>Means of sensitivity are not included in the table because not relevant differences were observed.

<sup>a,b</sup>Within a line, means without a common superscript letter differ (P<0.05).

regarding classification of consumers (sensitivity to AND, the propensity to reject meat with AND-related taint, and descriptors of AND smell), FREQ and GENMOD procedures were applied. The MIXED procedure was used to analyse the acceptability of odour and flavour by consumers, the model included the type of animal, sensitivity to AND and their interaction as fixed effects, session as blocking variable and consumer as random effect. Only the significant (P<0.05) interactions were kept in the model. Differences were declared at P<0.05 and tendencies at P<0.10.

### 3. Results and discussion

#### 3.1. Consumer sensitivity to androstenone

The distribution of consumers according to their sensitivity to AND is shown in Table 3. Considering all the consumers globally, 22.7% were high sensitive, 28.3% were middle sensitive and 49.0% were insensitive or low sensitive, and no significant differences were observed among countries. When AND sensitivity was grouped according to sex, women were more sensitive than men in UK, which is in agreement with previous studies carried out in other countries (Font i Furnols et al., 2009; Lunde et al., 2009; Weiler et al., 2000). Nevertheless, no significant differences were found in ES and FR. In the Spanish case, the global percentages of AND sensitivity were similar to those reported

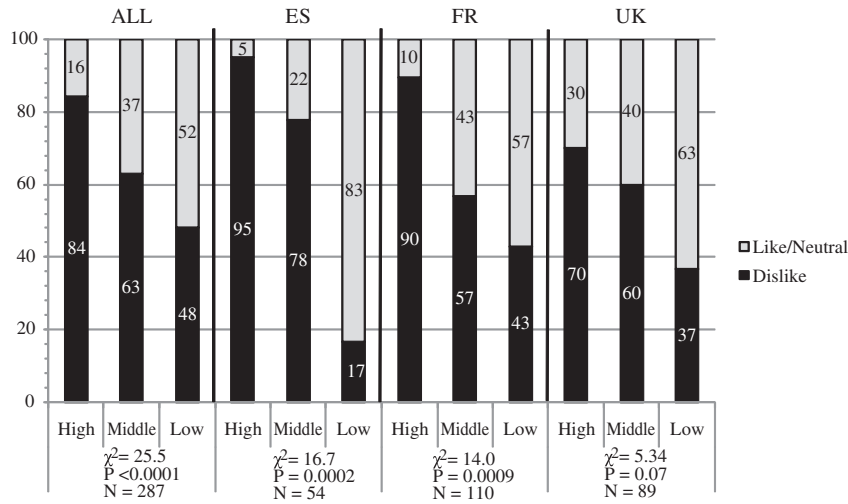
**Table 3**  
Classification of consumers (%) by country and according to their sensitivity to androstenone and gender.

Country	High sensitive	Middle sensitive	Insensitive or low sensitive	P-value gender
All countries	22.7	28.3	49.0	
Women	27.3	29.5	43.1	0.01
Men	18.4	27.4	54.2	
France	26.4	30.6	43.1	
Women	28.2	31.0	40.8	0.62
Men	25.0	30.6	44.4	
Spain	20.8	26.7	52.5	
Women	26.1	23.9	50.0	0.43
Men	16.4	29.1	54.5	
United Kingdom	20.4	27.2	52.4	
Women	27.4	31.5	41.1	0.005
Men	13.5	23.0	63.5	

previously (Font i Furnols et al., 2009; Weiler et al., 2000); however, this is the first time that no differences were found between men and women. In this study the percentage of sensitive men was higher than in previous works (Font i Furnols et al., 2009; Weiler et al., 2000). This variation could be due to an insufficient size sample. In addition, AND sensitivity was not affected by age in any country (data not shown), as observed previously (Font i Furnols et al., 2009). It is important to mention that comparisons among studies are problematic because of different methodologies and definitions/groups of sensitivity. Finally, it is important to highlight that, as far as the authors know this is the first time that results of AND sensitivity from French consumers are available in the literature, and the last results available from United Kingdom dated from twenty years ago (Gilbert & Wysocki, 1987).

The distribution of the liking of AND smell by sensitivity is presented in Fig. 1. Looking at the overall consumers who perceived some odour (scores from 1 to 8), 65% disliked the odour and the rest found it neutral or liked the smell. The percentage of disliking observed in this trial was approximately double that a previous one carried out in Spain (Font i Furnols et al., 2003). Moreover, the percentage of consumers that disliked AND increased with sensitivity to AND, as observed Font i Furnols et al. (2003). A significant effect of country (P=0.03) was observed in the high sensitive group of consumers, specifically the percentage of British consumers who disliked AND was lower than in ES and FR. The percentage of potential consumers that may reject tainted meat due to AND (Fig. 2) was between 14.3 and 30.6% in UK, 19.8 and 40.6% in ES, and 23.6 and 41.0% in FR (considering consumers who did not like AND smell and were 'High sensitive' or 'Middle and High sensitive' to this substance, respectively). Significant differences (P<0.05) were observed among countries, and the risk was lower in UK compared to ES and FR. One possible explanation is that in UK most of the male pigs are left entire; therefore consumers are probably used to finding boar meat in the market and they consider it as a normal odour/flavour of pork (Matthews et al., 2000); these results showed that the percentage of people that dislike this meat is lower in UK than in FR and ES.

The consumers tested for AND sensitivity were also asked to describe the smell of this substance. The consumers described AND with more than 60 adjectives which were grouped in various categories for the analyses (Table 4). Overall, the most used descriptors were 'Chemical' (19.8%), 'Animal' (14.3%), 'Sweet/Green' (14.3%), 'Fat' (10.9%), and 'Urine' (8.4%), followed with a lower percentage: 'Meat' (5.9%), 'Acid' (5.5%), 'Roast' (5.0%), 'Manure' (3.8%), 'Ammonia' (2.9%), 'Sweat' (2.1%), 'Rotten' (2.1%), and 'Others' (5.0%); whereas 17.6% of the total



**Fig. 1.** The distribution (%) of the liking of androstenone smell by androstenone sensitivity of consumers (High sensitive: score 7–8, Middle sensitive: score 4–6, and Low sensitive: score 1–3). ES: Spain, FR: France, UK: United Kingdom.

consumers could not associate the odour to any substance. Most of these descriptors have been previously described in taste panel tests (Annor-Frempong et al., 1997a, 1997b; Dijksterhuis et al., 2000) and consumers' (Lunde et al., 2009) tests, with the exception of 'Fat', 'Meat', 'Acid' and 'Roast'. The frequencies of descriptors used by sensitive and insensitive or low sensitive consumers to describe AND odour are presented in Fig. 3, and significant differences ( $P = 0.008$ ) in adjectives profile were observed by sensitivity. Differences were observed on the following descriptors: acid, animal, fat and sweet/green. The percentage of consumers that described AND odour as sweet/green and acid was higher ( $P < 0.05$  and  $P < 0.10$ , respectively) in insensitive group than in sensitive one; whereas the animal and fat descriptors were more used ( $P < 0.05$  and  $P < 0.10$ , respectively) to describe AND by sensitive consumers compared to insensitive group. These results agree with Lunde et al. (2009) who observed that sensitive consumers

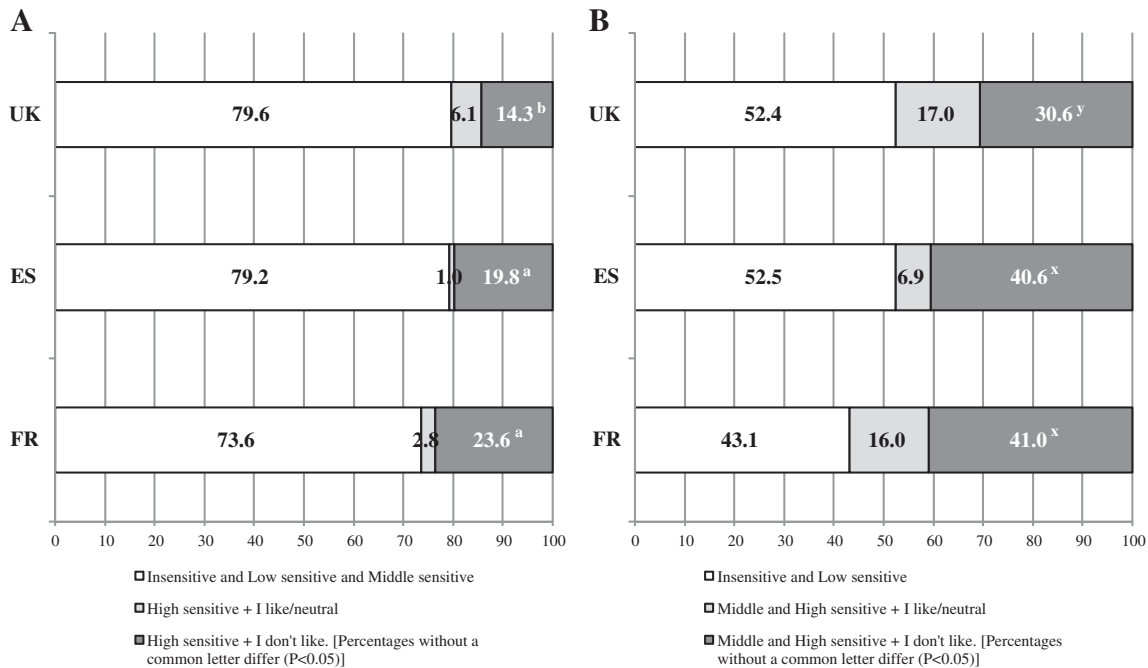
described AND using more negative attributes compared to insensitive consumers who used more positive ones. No significant differences with AND descriptors were observed among countries, origins (urban/rural) or genders (data not shown).

3.2. Acceptability of meat

The results of consumers' acceptability of pork tested in FR and ES/UK are presented in Table 1 and Table 2, respectively.

3.2.1. Acceptability by French consumers

Table 1 shows the results of the French consumer test performed in this study; it can be seen that Det+ meat obtained a lower 'Odour' score compared to Fe and Det-. This result indicates that the odour of meat from Det+ was less accepted by consumers than



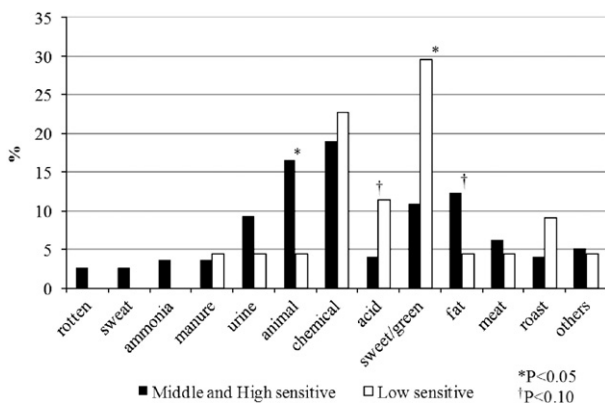
**Fig. 2.** The percentage of consumers with higher propensity to reject meat with androstenone-related taint, considering consumers who did not like androstenone smell and were either 'High sensitive' (A) or 'Middle and High sensitive' (B).



**Table 4**  
Androstenone descriptors given by consumers (within brackets: the number of times used as a descriptor).

Acid	Ammonia	Animal	Chemical	Fat	Manure	Meat	others	Roast	Rotten	Sweet	Sweet	Urine
Acid (8)	Ammonia (7)	Animal (14)	Anaesthetic (2)	Bacon (2)	Abattoir (1)	Meat (6)	Dusty (1)	Charred (3)	Rotten (5)	Sweet (5)	Aniseed (2)	Urine (20)
Vinegar (1)		Male (2)	Bleach (1)	Fat (17)	Dirty (2)	Pork (8)	Feeding stuff (1)	Curing (1)			Dressing (1)	
		Pig (18)	Chemical (19)	Oil (6)	Guts (1)		Gas (1)	Kitchen (2)			Firewood (1)	
			Cosmetic (2)	Rancid (1)	Manure (1)		Ground (2)	Roast meat (1)			Flowers (7)	
			Disinfectant (6)		Nappy (1)		Musty (1)	Roast oil (2)			Freshener (1)	
			Hospital (2)		Sewer (1)		Old (1)	Roast pork (2)			Fruit (3)	
			Insecticide (1)		Stable (2)		Plastic (1)	Roast (1)			Grass (1)	
			Medicine (10)				Smoked (2)				Hay (1)	
			Naphtaline (1)				Stuffy (1)				Pepper (2)	
			Soap (1)				Underbrush (1)				Perfume (3)	
			Solvent (1)								Plant (3)	
			White spirit (1)								Spices (1)	
											Sweet (6)	
											Vanilla (1)	
											Wood (1)	

meat from Fe or Det−, and this is in accordance with most of boar taint acceptability studies carried out before (Diestre et al., 1990; Font i Furnols et al., 2008). However, consumers did not differentiate between Fe and Det−. Based on these sensory evaluations, this result shows that if the concentration of AND and SKA are as low as in gilts, consumers could not distinguish between genders. This finding is in agreement with the results obtained by Font i Furnols et al. (2008), where no differences were reported between females and males with levels of AND <0.5 ppm. The present study also reported a significant interaction between type of meat and sensitivity when 'Strength of odour' and 'Abnormal odour' attributes were tested. Results from this trial (Table 1) showed that only high sensitive consumers found differences between different types of meat, where Det+ meat was scored higher in these terms. Besides, only significant difference in Det+ meat scores was observed among consumers' sensitivities, where the perception of high sensitive consumers for 'Strength of odour' and 'Abnormal odour' was higher compared to low and medium sensitive ones. Weiler et al. (2000) observed a tendency for highly sensitive consumers to score the high androstenone samples worse than those of low concentration. However, in this trial no differences were found in terms of overall acceptability ('Delicious') and taste. Our results confirmed that consumers' reaction was more negative in terms of odour than flavour as reported by previous bibliography (Desmoulin, Bonneau, Frouin, & Bidard, 1982; Font i Furnols et al., 2003; Matthews et al., 2000), probably due to volatility of AND and SKA which at high temperatures of cooking/heating meat (Agerhem & Tornberg, 1995) are released to the volatile fraction and they are easily perceived by the sense of smell (Claus, Schopper, Wagner, & Weiler, 1985; Denhard, Claus, Herbert, & Hillenbrand, 1995).



**Fig. 3.** Descriptors and their frequency used by Low sensitive (score 1–3) and Middle-High sensitive (score 4–8) consumers to describe the androstenone smell (N=238).

### 3.2.2. Acceptability by Spanish consumers

Table 2 shows that in general no changes were observed among different types of meat tested by Spanish consumers, with the exception of 'Odour'. Scores given by consumers indicated a lower acceptability of the odour of Det− pork compared to Det+, whereas no predilection was found between Fe and Det+. Our results could be related to data obtained by Font i Furnols et al. (2003); these authors observed in a consumer test carried out in Spain that, within samples with medium skatole levels, samples with medium AND levels (0.5–1.0 µg/g fat tissue) were scored worse than samples with low and high levels. Other authors reported a negative acceptability of boar taint meat only with meat samples with a concentration of AND higher than 1.0 µg/g fat tissue (Desmoulin et al., 1982; Diestre et al., 1990). In fact, if we express the AND levels used in the present study on fat tissue basis (instead of on pure fat basis; Ampuero et al., 2010) to compare them with previous papers, AND level of Det+ samples would be around 0.63 µg/g fat tissue, that represents a medium level. Therefore, it is very important to take into account the methodology used for AND analyses and the units used to express the results when comparing results from different studies.

### 3.2.3. Acceptability by British consumers

As shown in Table 2 the scores to the attributes 'Delicious', 'Taste' and 'Strength of odour' of Det− pork given by British consumers were lower compared to Fe, and no differences were found between Fe and Det+. These results could confirm the hypothesis explained in the Spanish case, because the samples tested in UK had the same concentration of AND as the ones used in ES. As discussed above, meat samples had medium AND levels (expressed on fat tissue basis instead of on pure fat basis), and therefore, according to Desmoulin et al. (1982) and Diestre et al. (1990) a level around 0.63 µg/g fat tissue could not be enough to be rejected by the consumers.

### 3.2.4. Overall acceptability

Regarding the results from the overall acceptability, divergences among countries were observed probably due to differences of the concentration levels of AND. As shown in Table 1 and Table 2, the Det+ meat used in FR had on average twofold concentration of AND compared to the meat used in ES and UK, which concentrations correspond to high and medium levels of AND respectively, as described Bonneau et al. (2000). Moreover the Det− meat used in FR had lower AND levels than meat used in ES and UK. Our results indicate that high levels of AND reduced the acceptability of boar meat; nevertheless medium AND levels could even improve this acceptability compared to pork with low levels resulting as positive as meat from females. However, this observation was obtained in two countries (ES and UK) where consumers can easily find boar meat in the market. These results agree with Font i Furnols et al. (2003) who

observed that samples with medium AND levels were scored better than samples with low and high levels. It is important to quantify the real impact of tainted carcasses in the market because, based on the present results, only carcasses with high AND level would reduce consumers' acceptability. Other results from the same study not included in this paper (ALCASDE, 2009) reported that the percentage of high tainted carcasses was between 10 and 25%, although this percentage should be considered with caution because a higher number of carcasses need to be tested to be fully representative for the whole European pig population.

In addition, overall acceptability of tainted meat observed in the present work (even French meat with a high level of AND) was better compared to other studies. This fact could be explained by the different cooking method used in this trial with respect to the other ones. The present study tried to reproduce home preparation which means that meat was cooked in hot plates instead of being cooked in the oven (in small and closed containers). It is reported that it is more difficult to detect boar taint using hot plates than in the oven (Béague, Siret, Fischer, & Chevillon, 1997; Siret, Béague, Fischer, & Chevillon, 1997). For this reason, it is important to take into account the differences in the cooking/consumer's study methodology and be cautious with the comparisons because results can be very different (Ampuero et al., 2010). It is also the case of the different methods used to determine AND concentration, which can originate discrepancies between studies.

#### 4. Conclusions and implications

As a result of the growing concern about animal welfare, and in view of the possible ban of pig castration in Europe in the coming years, it is really important to quantify the potential consequences (on the meat quality, on economy, etc.). The present study reported that the percentage of consumers that may reject tainted meat due to AND sensitivity is between 14.3 and 41.0%. Besides, our results indicated that only high levels of AND reduce the acceptability of boar meat, and pork with medium levels of AND could even improve its acceptability. However, more studies are needed to confirm these results including more countries, and increasing the number of carcasses tested. A harmonisation of analytical methodologies to determine comparable threshold levels is also required.

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