STUDY OF THE PREVALENCE OF BOAR TAINT IN SPANISH COMMERCIAL PIGS BY CHEMICAL ANALYSIS

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Abstract – The presence of boar taint in entire male pigs might be a problem for consumers that consider it as an off and undesirable odour and flavour (between 10 to 48% of consumers). Objective knowledge of the prevalence of carcasses with boar taint could be useful for the pig sector in order to avoid speculations and to know the scope of the topic. Consumers' thresholds for the two main compounds responsible of boar taint have been defined in previous studies as 0.20 µg/g of fat for skatole and 1.0 µg/g of fat for androstenone. The aim of this study was to determine the prevalence of boar taint in Spanish farms. A total of 903 samples from subcutaneous fat from entire male pigs were selected, and as a preliminary result, skatole and androstenone content is studied in 451 samples using human nose methodology and chemical analysis. According to these results and the thresholds defined, samples were then classified as low, medium and high levels of boar taint. Results showed that 24 % had low skatole levels, 6 % had medium levels and 10 % high levels, and 60.3% had levels below the threshold. With regard to androstenone levels, 13 % had low levels, 8 % medium levels and 6 % high levels, and 73.4% had levels below the threshold.

I. INTRODUCTION

Pig production is one of the major activities in Spain. The castration of male piglets is estimated to be carried out on less than 20 %, according to sector information of the total production, mainly to avoid the presence of boar taint in meat and pork products that may affect consumers' acceptance [1-2]. Percentage of consumers who perceived the meat odour as abnormal varied between 10 to 48% depending on the boar taint concentration [3]. Boar taint is mainly due to the accumulation in the fat of two compounds: skatole, a breakdown product of the amino acid tryptophan in the large intestine [4], and androstenone, a pheromone produced in the testis [5]. Although skatole is perceived by 99% of consumers, some consumers are anosmic for androstenone and therefore are not able to perceive it [6]. The common accepted thresholds are 0.20 µg/g of fat for skatole and 1.0 µg/g of fat for androstenone [7]. In an European study conducted in six countries between 1995 and 1996 over 4000 entire male pigs were studied, overall the 29% of pigs had levels above the threshold of 1.0 µg/g for androstenone and the 15% had levels above 0.20 µg/g for skatole. In Spain about 22.5 % of entire male pigs had skatole levels above 0.25 µg/g and 42 % had androstenone levels above 1.0 µg [8].

No recent studies about skatole and androstenone levels in pigs from the Spanish farms are available, so the objective of this study was to know the prevalence of boar taint in Spanish entire male pigs' production, by measuring skatole and androstenone levels using human nose methodology and chemical analysis.

II. MATERIALS AND METHODS

Subcutaneous fat samples from commercial entire male pigs were collected in 5 Autonomous Regions (Aragón, Catalunya, Castilla y León, Madrid and Murcia). Thirty Spanish farms were screened, 6 farms from each region and 30

samples per farm. Crossbreed, hot carcass weight and fat thickness at the last rib level were recorded with a ruler for each pig.

Presence of boar taint was firstly scored with the methodology known as human nose using a soldering iron [9]. In this study 3 trained panellists identified fat samples with presence/absence of boar taint. Samples with presence of boar taint (according to the human nose) were all analysed. Detection limits of panellists were 0.20 µg/g of adipose tissue for androstenone and 0.03 µg/g of adipose tissue for skatole, so samples classified as 'absence of boar taint' by the panellists were considered to have <0.20 µg/g of adipose tissue for androstenone and <0.03 of adipose tissue µg/g for skatole. Considering samples identified as free of boar taint, one 'negative' sample from each farm was also analyzed.

Skatole and indole concentrations in fat were determined in a subsample by HPLC (High-performance liquid chromatography) methodology described by García-Regueiro *et al.* [10], androstenone concentration was determined according to Rius *et al.* [11] by GC-MS (Gas chromatography–mass spectrometry). According to the levels of Androstenone and skatole, samples were classified as follows [12]:

For skatole (SKA):

- No boar taint: <0.03 µg/g adipose tissue
- Low: 0.03≤ SKA<0.10 µg/g adipose tissue
- Medium: 0.10≤ SKA <0.19 µg/g adipose tissue
- High: SKA ≥0.20 µg/g adipose tissue

For androstenone (AND):

- No boar taint: <0.2 µg/g adipose tissue
- Low: 0.2≤ AND <0.5 µg/g adipose tissue
- Medium: 0.5≤ AND <1.0 µg/g adipose tissue
- High: AND ≥1.0 µg/g adipose tissue

Statistical analysis was performed using the SAS software (SAS Institute Inc., Cary, Nc, USA v. 9.2). Means and standard deviation of hot carcass weight (kg), Fat thickness (kg), skatole (µg/g adipose tissue) and Androstenone (µg/g adipose tissue) were calculated using mean procedure of SAS. Differences between Spanish regions were studied using the mixed procedure of SAS. Hot carcass weight was included as covariate when calculating Fat thickness. Differences were adjusted with Tukey's test. Significance level was fixed at P<0.05.

III. RESULTS AND DISCUSSION

A total of 903 samples were screened from 5 autonomous regions: Aragón (n=180 from 6 farms and 2 abattoirs), Catalunya (n=180 from 6 farms and 2 abattoirs), Castilla y León (n=180 from 6 farms and 1 abattoir), Madrid and Castilla la Mancha (n=180 from 6 farms and 1 abattoir), and Murcia (n=183 from 6 farms and 1 abattoir).

Results showed significant differences among Autonomous Regions in carcass weight (P<0.001). Castilla y Leon showed the highest carcass weight (lsmeans= 85.3±0.56kg), and Murcia (lsmeans= 75.5±0.56 kg) and Madrid and Castilla la Mancha (lsmeans= 77.5±0.56 kg) showed the lowest (Table 1). With regard to the crossbreed, most of the pigs (73.4 %) were Pix(LWxLS), the rest were crossbreds such as (LWxLS)xDu and Pix(LSxMS).

Table 1. Mean, standard deviation, minimum and maximum values of hot carcass weight and fat thickness.

Hot carcass weight (kg)	mean	SD	min	max
Aragón	80,4	8,20	57,0	105,4
Catalunya	78,1	7,05	57,5	102,5
Castilla y León	85,4	8,02	65,6	119,6
Madrid y Castilla la Mancha	77,5	7,00	58,6	100,8
Murcia	75,5	7,37	46,5	98,8
Global	79,3	8,26	46,5	119,6

Last rib fat thickness (mm)	mean	SD	min	max
Aragón	18,7	4,33	2	30
Catalunya	16,6	3,91	5	26
Castilla y León	18,8	4,13	9	30
Madrid y Castilla la Mancha	19,3	6,09	4	35
Murcia	18,7	6,11	5	35
Global	18,4	5,09	2	35

As a preliminary result, a subsample of 451 samples from Aragón, Catalunya and Murcia was first classified with a trained panel using the human nose method. A total of 267 samples were classified as absence of boar taint by the 3 panellists. Fourteen samples (one sample from each farm at random) classified as 'absence of

boar taint' were analysed for boar taint compounds to confirm the answer of the panellists. Samples classified as 'absence of boar taint' had low levels for skatole (0.04 ± 0.012 µg/g adipose tissue) and low levels for androsntenone (0.18 ± 0.166 µg/g adipose tissue). Samples classified as 'presence of boar taint' by the 3 panellists, were all analysed for the androstenone and skatole levels. Table 2 shows androstenone and skatole levels of all the samples, including those evaluated as 'absence of boar taint' by the panellists. Considering 451 samples studied, 24 % had low levels of skatole, 5.5 % showed medium levels and 10.2 % of samples showed high levels of skatole, and 60.3 % had boar taint levels below the threshold. With regard to androstenone levels, 12.6 % showed low levels, 8.4 % showed medium levels and 5.6 % showed high levels, and 73.4 % had boar taint levels below the threshold.

Table 2. Skatole and androstenone content (µg/g adipose tissue) in commercial carcasses.

Skatole (µg/g adipose tissue)					
	N	mean	SD	min	max
no boar taint (<0.03) [1]	272 (60.3%)	0.00	0.004	0.00	0.02
low (0.03-0.1)	108 (24.0%)	0.06	0.018	0.03	0.09
medium (0.1-0.2)	25 (5.5%)	0.15	0.027	0.10	0.19
high (>0.2)	46 (10.2%)	0.40	0.207	0.20	1.16
Global	451 (100%)	0.06	0.140	0.00	1.16
Androstenone (µg/g adipose tissue)					
	N	mean	SD	min	max
no boar taint (<0.20) [1]	331 (73.4%)	0.02	0.039	0.00	0.20
low (0.2-0.5)	57 (12.6%)	0.33	0.076	0.22	0.49
medium (0.5-1.0)	38 (8.4%)	0.71	0.140	0.50	0.99
high (>1.0)	25 (5.6%)	1.78	0.959	1.02	4.77
Global	451 (100%)	0.06	0.425	0.00	4.77

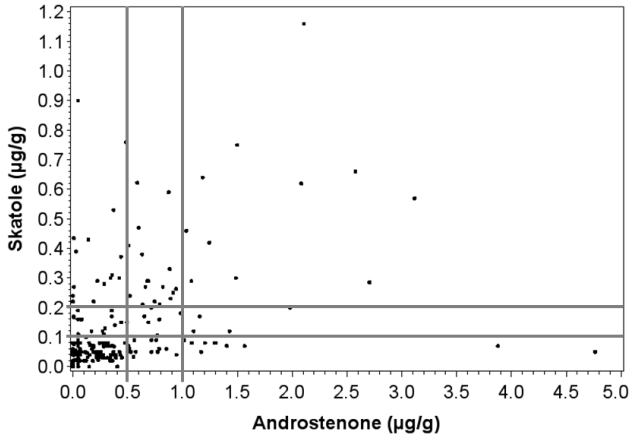
[1] No boar taint includes samples classified with the human nose panellists.

Fig. 1 shows the distribution of androstenone and skatole levels of the studied samples.

IV. CONCLUSION

Although the presence of entire male pigs with high levels of boar taint in Spanish farms was not high in percentage, in absolute number of animals it might be a problem for consumers that reject boar tainted meat, because it means a noteworthy number of pigs, taking into account the high number of pigs annually produced in Spain. Consumer studies are needed to ascertain the rejection levels and to know the percentage of preferences and liking of the meat and meat products, and then the sector might take decisions about it.

Figure 1. Androstenone and skatole levels (µg/g adipose tissue)



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REFERENCES

1. Diestre, A., M.A. Oliver, M. Gispert, I. Arpa & J. Arnau, (1990). Consumer responses to fresh meat and meat products from barrows and boars with different levels of boar taint. Anim Sci. 50(03): 519-530.

2. Font i Furnols, M., L. Guerrero, X. Serra, M.A. Rius & M.A. Oliver, (2000). Sensory characterization of boar taint in entire male pigs. J Sens Stud. 15(4): 393-409.

3. http://www.alternativepig.eu ALCASE Final Report (2009)

4. Vold, E., (1970). Fleischproduktionseigenschaften bei Ebern und Kastraten IV: Organoleptische und gaschromatographische Untersuchungen wasserdampfflüchtiger Stoffe des Rücken-speckes von Ebern. Meld Norg Landbruks. 49: 1-15.

5. Patterson, R.L.S., (1968). 5α-androst-16-ene-3-one:—Compound responsible for taint in boar fat. J Sci Food Agric. 19(1): 31-38.

6. Wysocki, C.J. & G.K. Beauchamp, (1984). Ability to smell androstenone is genetically determined. P Natl Acad Sci USA. 81(15): 4899-4902.

7. Bonneau, M., M. Le Denmat, J.C. Vaudelet, J.R. Veloso Nunes, A.B. Mortensen & H.P. Mortensen, (1992). Contributions of fat androstenone and skatole to boar taint: I. Sensory attributes of fat and pork meat. Livest Prod Sci. 32(1): 63-80.

8. Walstra, P., C. Claudi-Magnussen, P. Chevillon, G. von Seth, A. Diestre, K.R. Matthews, D.B. Homer & M. Bonneau, (1999). An international study on the importance of androstenone and skatole for boar taint: levels of androstenone and skatole by country and season. Livest Prod Sci. 62(1): 15-28.

9. Mathur, P.K., J. ten Napel, S. Bloemhof, L. Heres, E.F. Knol & H.A. Mulder, (2012). A human nose scoring system for boar taint and its relationship with androstenone and skatole. Meat Sci. 91(4): 414-422.

10. García-Regueiro, J.A. & M.A. Rius, (1998). Rapid determination of skatole and indole in pig back fat by normal-phase liquid chromatography. J Chromatogr A. 809(1-2): 246-251.

11. Rius, M.A. & J.A. García-Regueiro. (1998). Analysis of androstenone in pig back fat by solid-phase extraction and GCMS. In Proceedings of the 44th International Congress of Meat Science and Technology (pp. 584-586), Aug 30-Sept 4, Barcelona, Spain.

12. Bonneau, M. & P. Chevillon, (2012). Acceptability of entire male pork with various levels of androstenone and skatole by consumers according to their sensitivity to androstenone. Meat Sci. 90(2): 330-337.