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Sensory Quality of Meat from Crossbred Boars in Relation to their Age and Slaughter Weight

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Abstract

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The aim of this study was to evaluate the effect of age of boars and their slaughter weights on the pleasantness and intensity of pork meat taste and odour. A total of 652 sensory evaluations of meat samples from sixteen crossbred entire male pigs aged 121 to 136 days with slaughter weight of 80–120 kg were performed by sensory profiling method. The age was a greater factor influencing the level of boar taint than the slaughter weight of animals. There were significant differences in the intensity of boar odour between categories of young animals (121 days) and old animals (135–136 days) (P = 0.0473) and between categories of adult animals (128 days) and old animals (P = 0.0194). Among the evaluated descriptors stronger correlations were calculated between olfactometric than between taste descriptors. Significant correlations were found between androstenone levels in subcutaneous fat and the results of sensory evaluation of muscle samples from the oldest animals aged 135–136 days.

Keywords: boar age; boar taint; live weight; sensory analysis; sexual maturation

Boar taint is a very unpleasant odour released mainly by the heating of fat of carcasses from male pigs. The main contributors responsible for boar taint are androstenone (5α-androst-16-en-3-one) and skatole (3-methylindole). Both of these compounds are important in boar taint perception (Annor-Frempong *et al.* 1997), although there is a stronger negative reaction towards skatole (Cameron *et al.* 2000).

Androstenone is a steroid with a urine or perspiration like sweaty odour (Aldal *et al.* 2005). Its content depends on many factors including sexual development, age and body weight of the animal, genetic factors, feeding and keeping males and females together (Walstra *et al.* 1999).

Skatole is a degradation product of tryptophan produced by special bacteria in the large intestine. It has a bitter taste and gives a faecal-like, naphthalene, sweet, warm and fruity odour to the meat samples (Rius *et al.* 2005). The most important factors affecting skatole's level in meat are feeding (Aluwé *et al.* 2009) and rearing conditions (Bonneau 1998). Skatole and androstenone are not able to completely explain sensory boar taint. Other compounds like indole, other 16-androstenone steroids, 4-phenyl-

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3-buten-2-one, *p*-cresol, 4-ethylphenol and short chain fatty acids are also involved (Garcia-Regueiro & Diaz 1989; EFSA 2004).

Boar taint does not appear in all male animals. It is detected in only 1–30% of boars aged 20-24 weeks when pigs usually reach their standard carcass weight (Jensen *et al.* 1995).

In some countries, boars are slaughtered at the beginning of their sexual maturity (up to 110 kg of their weight), and their surgical castration is not necessary in these cases. However, in most European countries pigs are fattened to a higher weight (about 120 kg) and in the case of animals intended for the production of specialties (for example some kinds of ham) they are fattened up to 140 kg. In these cases, castration is necessary (Fredriksen & Nafstad 2006). Greater weight often relates to the age of the animals. The concentration of androstenone and skatole in adipose tissue increases with the age of boars (Zamaratskaia *et al.* 2004). During booster puberty, there is an increased production of androstenone, which subsequently correlates with skatole (Andersson *et al.* 1999).

The aim of this study was to evaluate the effect of age of boars and their slaughter weights on the pleasantness and intensity of pork meat taste and odour.

MATERIAL AND METHODS

Animals. Sixteen crossbred Duroc × (Large White Landrace) entire male pigs fed *ad libitum* with complete feed mixtures were used in this experiment. The animals were housed at the age of 69 days, with an average live weight of 29.2 kg. They were maintained in an air-conditioned barn placed in pens of 2 animals of the same gender and the same diet group.

At the end of the feeding period, the pigs were slaughtered according to the protocols for certified Czech slaughterhouses under the supervision of an independent veterinarian. Before dissection, the carcasses were stored at +2°C for 24 hours. Meat samples of loin (*musculus longissimus lumborum et thoracis*) from boars aged 121 days (Y – young animals), 128 days (A – adult animals) or 135–136 days (O – old animals) and the slaughter weight of 80 to 120 kg were collected for sensory analysis 24 h after slaughter and frozen without skin in a vacuum package at –18°C until the evaluation.

For the detailed results evaluation, the animals were divided into three slaughter weight categories: 80 kg (S – small), 100–108 kg (M – medium) and 115–120 kg (L – large). The levels of androstenone and skalote in backfat of animals analysed by HPLC method were 0.911–14.483 µg/g for androstenone and 0.106–0.316 µg/g for skatole (Okrouhlá *et al.* 2016).

Sensory analysis. Sensory evaluation for taste and odour of the samples was performed according to ISO 8589:2007 by panellists selected according to Meier-Dinkel *et al.* (2013). The sensory panellists comprised 30 university students and employees at the age from 22 to 63 years (37% males, 63% females). Each sensory evaluation was performed by 9 assessors.

Frozen samples of loin were thawed overnight at 4°C. Back fat layer were taken off; no salt or additives were applied. Meat samples were cut into cubes of 1 cm^3 (10 ± 0.5 g pieces), placed into 50-ml beakers covered by watch glass, heated in water baths (set to 73°C for 15 min) to reach and hold on an internal temperature of 68°C for 8 min (Aldal *et al.* 2005) and served within 3 minutes. Three or four different samples were randomly served to each panellist in one session. A total of 652 sensory evaluations were carried out within 20 sessions. Linear unstructured graphical 100mm scales oriented by description at both ends were used for sensory profile evaluation (ISO 13299:2016) of six descriptors given in Table 1 (Font i Furnols *et al.* 2009).

Statistical analysis. The data obtained were analysed using Statistica 12.0 software (StatSoft Inc.). Analysis of variance (two-way ANOVA), correlation matrix and principal component analysis (PCA) were performed. The significant differences in the means were separated using the Sheffe's test. For all statistical tests, a 5% level of significance was used.

RESULTS AND DISCUSSION

The effect of age and weight on sensory evaluation of meat. The results from sensory evaluation of all samples (Table 1) show that the values for mean and median were more or less the same. Considering evaluation of individual weight categories, the results are shown in Figure 1. The only significant differences were found in the intensity of boar odour between M and L categories ($P = 0.0044$). The mean value of this parameter increased from 42% and 39% (categories S and M) to 47% (category L) (Figure 1). The results of other parameters including the intensity of boar taste did not change at all ($P < 0.05$).

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Table 1. Descriptive characteristics of results from sensory evaluation of meat samples

Descriptor	Mean	Median	SD
		(%)	
Pleasantness of odour	45	45	18
Overall intensity of odour	53	54	20
Intensity of boar odour	43	42	25
Pleasantness of taste	45	45	18
Overall intensity of taste	53	54	16
Intensity of boar taste	40	40	24

SD = standard deviation; n = 652; pleasantness: 0% (0 mm) – rejectable, 100% (100 mm) – excellent; intensity: 0% (0 mm) – imperceptible, 100% (100 mm) – very strong

The pleasantness of odour and taste (Table 1) was assessed at the same level, as well as the overall intensity of odour and taste. The intensity of boar odour was slightly stronger compared to the intensity of boar taste. According to Matthews *et al.* (2000) boar odour is more strongly linked with skatole than with androstenone, whereas flavour correlates equally with skatole and androstenone. The same authors also stated that consumers are better able to differentiate in odour than in flavour.

The results of sensory evaluation of individual age categories are shown in Figure 2. The only significant differences were in the intensity of boar odour between both categories Y and O (P = 0.0473) and between categories A and O (P = 0.0194). The difference in the intensity of boar odour between O category (45%) and other categories (38% in case of Y and 37% in case of A) can be clearly seen in Figure 2, while the differences in the intensity of boar taste and other evaluated descriptors were neither large nor significant (P < 0.05).

Our results (Figures 1 and 2) demonstrated the effect of age and slaughter weight on the hedonic and intensity descriptors evaluated by sensory analysis of pork meat. The effect of the weight on the boar taint is in line with Moore *et al.* (2017). The effect of age on androstenone, skatole and indole levels was confirmed by Rostellato *et al.* (2015).

Comparing the effect of slaughter weight and the age of the animals at the time of slaughter, the influence of age is the most important risk factor of the boar taint in the sample. Boars aged 135 and 136 were statistically significantly different from the younger age categories, even though they were in the slaughter weight range of all weighing categories 80–120 kg.

The effect of weight to the boar taint occurrence has been proven, but according to Jaturasitha *et al.* (2006) it is minimal up to 80 kg of the animals' slaughter weight. The most important factor relating to the slaughter weight is the age of animals. According to Parunović *et al.* (2010) androstenone content in fat tissue increases with the weight, while the skatole content decreases. Also, Zamaratskaia and Squires (2009) stated that the sexual maturation and age have the greatest impact on the concentration of androstenone and skatole in pork.

Correlations between variables. The significant correlations between the evaluated descriptors were the highest between overall intensity of odour and intensity of boar odour (P = 0.635), intensity of boar odour and intensity of boar taste (P = 0.627) and pleasantness of odour and intensity of boar odour

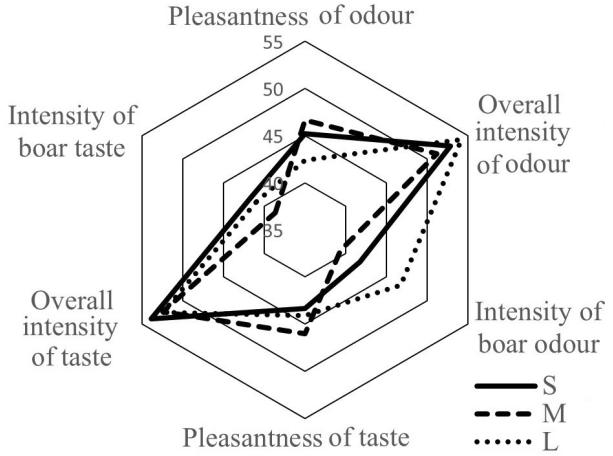

Figure 1. Sensory analysis of boar meat from different weight categories of animals (S – small, M – medium, L – large)

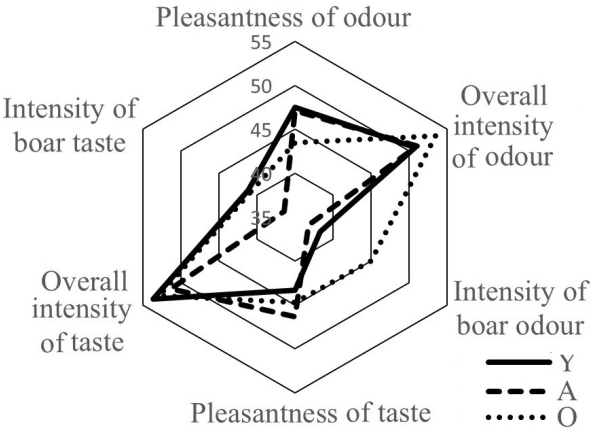

Figure 2. Sensory analysis of boar meat from different age categories of animals (Y – young, A – adults, O – old)

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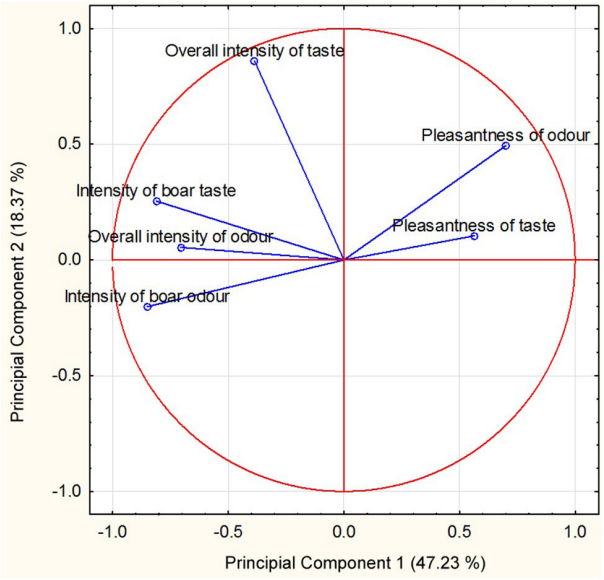

Figure 3. PCA results – variables factor map

(P = –0.368). These closer relationships of odour variables comparing to the taste descriptors could be seen from the results of the PCA analysis (Figure 3).

Focussing on the effect of age and animal weight, the intensity of boar odour correlated with the age of the animal more significantly than the slaughter weight. The age of the animal also correlated with the pleasantness of taste, which was not significant in the case of slaughter weight. Correlations of sensory descriptors and androstenone or skatole levels in backfat were small (below ± 0.3). They were higher and significant for androstenone than for skatole as well as for odour descriptors than for taste descriptors.

When considering weight classification, there were high correlations between the intensity of the boar odour and the intensity of the boar taste (rS = 0.677, rM = 0.642, rL = 0.591) and between the overall intensity of odour and intensity of boar odour (rS = 0.624, rM = 0.584, rL = 0.680). The results of the correlation of sensory parameters of the muscle samples and the levels of androstenone and skatole in backfat showed that the S group animals had a weak correlation between odour descriptors and skatole content (concentrations in this group were 0.113–0.291 μg/g). Weak correlations were also found in the L group between androstenone values (1.816–14.483 μg/g) and the sensory evaluation of all olfactometric descriptors together with the intensity boar taste. All other correlations were not significant.

When dividing samples into age groups, the correlation coefficients were, in each category, mostly higher than in the weight distribution. Very high correlation coefficients were obtained between the intensity of the boar odour and the intensity of the boar taste (rY = 0.6916, rA = 0.6341, rO = 0.6159) and between the overall intensity of odour and the intensity of boar odour (rY = 0.6025, rA = 0.5976, rO = 0.6488). The correlations between sensory descriptors and levels of androstenone or skatole were statistically insignificant in all age groups. The only exception were statistically significant weak correlations between almost all sensory descriptors and androstenone levels in the O group (androstenone concentrations in backfat were 0.911–14.483 μg/g).

According to our results the age of entire male pigs over 135 days resulted in higher occurrence of the boar taint. This finding supports the necessity to manifest a high breeding ability of boars which enables them to reach sufficient slaughter weight at younger age with minimisation of unpleasant boar taint occurrence. This supports also the findings of VAN DEN BROEKE *et al.* (2015) who stated that with the age of animals, the proportion of not only intramuscular but also subcutaneous fat increases, which increases the accumulation of skatole and androstenone. Our results from significant correlations found between androstenone levels in subcutaneous fat and the results of sensory evaluation of muscle samples in the oldest animal category are consistent with those findings.

CONCLUSIONS

Sensory evaluation of meat from entire boars showed that the age of animals was more important factor influencing the level of boar taint than their slaughter weight. Meat from boars at the age of 135 and 136 days, significantly differed from the meat of younger animals, no matter on their carcass weights. Stronger correlations were calculated between olfactometric descriptors than between taste descriptors. Delayed sexual maturation could be effective against the occurrence of boar taint in non-castrated male pigs.

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References

Aldal I., Andresen O., Egeli A.K., Haugen J.E., Grodum A., Fjetland O., Eikaas J.L.H. (2005): Levels of androstenone

https://doi.org/10.17221/151/2018-CJFS

and skatole and the occurrence of boar taint in fat from young boars. Livestock Production Science, 95: 121–129.

Aluwe M., Millet S., Nijs G., Tuyttens F.A.M., Verheyden K., de Brabander H.F., de Brabander D.L., van Oeckel M.J. (2009): Absence of an effect of dietary fibre or clinoptilolite on boar taint in entire male pigs fed practical diets. Meat Science, 82: 346–352.

Annor-Frempong I.E., Nute G.R., Whittington F.W., Wood J.D. (1997): The problem of taint in pork-III. Odour profile of pork fat and the interrelationships between androstenone, skatole and indole concentrations. Meat Science, 47: 63–76.

Andersson H.K., Hullberg A., Malmgren L., Lundstrom K., Rydhmer L., Squires J. (1999): Sexual maturity in entire male pigs – Environmental effects, relations to skatole level and female puberty. Acta Agriculturae Scandinavica Section A-Animal Science, 49: 103–112.

Bonneau M. (1998): Use of entire males for pig meat in the European Union. Meat Science, 49: S257–S272.

Cameron N.D., Penman J.C., Fisken A.C., Nute G.R., Perry A.M., Whittington F.W. (2000): Boar taint in pigs selected for components of efficient lean growth rate. Meat Science, 54: 147–153.

Fredriksen B., Nafstad O. (2006): Surveyed attitudes, perceptions and practices in Norway regarding the use of local anaesthesia in piglet castration. Research in Veterinary Science, 81: 293–295.

Font i Furnols M., Gonzalez J., Gispert M., Oliver M.A., Hortos M., Perez J., Suarez P., Guerrero L. (2009): Sensory characterization of meat from pigs vaccinated against gonadotropin releasing factor compared to meat from surgically castrated, entire male and female pigs. Meat Science, 83: 438–442.

Garcia-Regueiro J.A., Diaz I. (1989): Evaluation of the contribution of skatole, indole, androstenone and androstenols to boar-taint in back fat of pigs by HPLC and capillary gas chromatography (CGC). Meat Science, 25: 307–316.

Jaturasitha S., Pichitpantapong S., Leangwunta V., Khiaosa-Ard R., Suppadit T., Kreuzer M. (2006): Increasing the slaughter weight of boars: Effects on performance and pork quality. Journal of Applied Animal Research, 30: 19–24.

Jensen M.T., Cox R.P., Jensen B.B. (1995): Microbial production of skatole in the hind gut of pigs given different diets and its relation to skatole deposition in backfat. Animal Science, 61: 293–304.

Matthews K.R., Homer D.B., Punter P., Beague M.P., Gispert M., Kempster A.J., Agerhem H., Claudi-Magnussen C., Fischer K., Siret F., Leask H., Furnols M.F.I., Bonneau M. (2000): An international study on the importance of androstenone and skatole for boar taint: III. Consumer survey in seven European countries. Meat Science, 54: 271–283.

Meier-Dinkel L., Sharifi A.R., Tholen E., Frieden L., Bucking M., Wicke M., Morlein D. (2013): Sensory evaluation of boar loins: Trained assessors' olfactory acuity affects the perception of boar taint compounds. Meat Science, 94: 19–26.

Moore K.L., Mullan B.P., Dunshea F.R. (2017): Boar taint, meat quality and fail rate in entire male pigs and male pigs immunized against gonadotrophin releasing factor as related to body weight and feeding regime. Meat Science, 125: 95–101.

Okrouhlá M., Stupka R., Čítek J., Urbanová D., Vehovský K., Kouřimská L. (2016): Method for determination of androstenone, skatole and indole in dorsal fat of pigs. Chemické Listy, 110: 593–597.

Parunović N., Petrović M., Matekalo-Sverak V., Parunović J., Radović Č. (2010): Relationship between carcass weight, skatole level and sensory assessment in fat of different boars. Czech Journal of Food Sciences, 28: 520–530.

Rius M.A., Hortos M., Garcia-Regueiro J.A. (2005): Influence of volatile compounds on the development of off-flavours in pig back fat samples classified with boar taint by a test panel. Meat Science, 71: 595–602.

Rostellato R., Bonfatti V., Larzul C., Bidanel J.P., Carnier P. (2015): Estimates of genetic parameters for content of boar taint compounds in adipose tissue of intact males at 160 and 220 days of age. Journal of Animal Science, 93: 4267–4276.

Van den Broeke A., Aluwe M., Janssens S., Wauters J., Vanhaecke L., Buys N., Millet S., Tuyttens F.A.M. (2015): The effect of the MC4R gene on boar taint compounds, sexual maturity and behaviour in growing-finishing boars and gilts. Animal, 9: 1688–1697.

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

Zamaratskaia G., Babol J., Andersson H., Lundström K. (2004): Plasma skatole and androstenone levels in entire male pigs and relationship between boar taint compounds, sex steroids and thyroxine at various ages. Livestock Production Science, 87: 91–98.

Zamaratskaia G., Squires E.J. (2009): Biochemical, nutritional and genetic effects on boar taint in entire male pigs. Animal, 3: 1508–1521.

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