8:12 Boar taint and bitter taste as affected by androstenone and skatole

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Introduction

The use of entire male pigs for meat production has, in spite of better production characteristics, not been widely adopted either in Sweden or in most other European countries. The reason is of course the problem of tainted carcasses.

The main contributing component to boar taint is considered to be 5α-androst-16-ene-3-one (androstenone), but skatole (3-methyl-indole) has also been demonstrated in tainted boar fat (Vold, 1970; Walstra & Maarse, 1970; Maarse et al., 1972). A significant correlation between androstenone and skatole was found by Hansson et al. (1980).

If a rapid and safe screening test could be used on the slaughter line, tainted carcasses could be sorted out for use in special products. One such rapid testing method has recently been developed in Denmark (Mortensen & Sørensen, 1984). The method, which is based on the analysis of skatole, may prove to be very useful on the slaughter line.

The production of skatole in the pig is not fully understood, but one origin is through putrefaction in the intestine. The content of crude fibre in the diet has been shown to influence the activity of the gut flora (Just et al., 1983) which in turn may affect the amount of skatole produced.

The purpose of the present investigation was to study the relationship between androstenone, skatole and sensorially evaluated variables concerning boar taint and taste. We also intended to evaluate the effect of nutrient density level on the above parameters.

Material and methods

Animals

The animals used in this study were 143 purebred Swedish Yorkshire boars. In addition 41 littermate gilts were included as a control material reared under the same conditions. The boars were reared on two different feeds, with either a high nutrient density, 13.7 MJ/Kg, or a low density, 11.7 MJ/Kg. The amounts fed were adjusted so that total daily energy and protein intake was the same for both groups. All animals were slaughtered at a live weight of approximately 110 kg.

Chemical analysis

Androstenone (5α-androst-16-ene-3-one) in fat was determined according to the extraction and radioimmunological procedure described by Andresen (1975). Androstenone was analysed in duplicate and calculated in ppm extractable fat.

Skatole was analysed with the newly developed Danish method as described by Mortensen & Sørensen (1984). The concentration was expressed as skatole-equivalents (ppm in fat, wet weight).

Sensory evaluation

Boar taint intensity of backfat (lumbar region) was evaluated by heating the fat samples to 150°C with the tip of a soldering iron (Jarmoluk et al., 1970). Each sample was judged by a panel consisting of at least 6 persons on a 5-point scale, ranging from 1 (= no boar taint) to 5 (= strong boar taint).

Sensory evaluation of meat was done on samples from *M. longissimus dorsi*. At jointing 3 days after slaughter, samples were taken from the muscle cut at the tip of the last rib and 50 mm cranially. The samples were put into plastic bags and were kept at +4°C for 2 days before freezing at -20°C. The meat was thawed at +4°C for 16 hours, cut into 10 mm thick slices and wrapped in aluminium foil. No spices were added. The samples were heated in an oven for 30 min at 180°C. At each sensory evaluation, four boar samples and at least one sample from a littermate gilt were judged. A panel consisting of 2 or 3 persons did the scoring of samples for boar taint (same scale as backfat), overall taste, bitter taste and tenderness. The scales for overall taste and tenderness ranged from 1 (acceptable) to 3 (not acceptable), and for bitter taste from 1 to 4 (4 = very bitter taste).

Statistical analysis

All calculations were performed with the Statistical Analysis System (SAS Institute Inc., 1982). The statistical model used included litter, nutrient density level and, when significant, the interaction between these.

Results

Means and standard deviations for androstenone in backfat from boars and for skatole (e.g. skatole equivalents) in backfat from boars and littermate gilts are given in Table 1. The distribution for both substances - but especially for skatole - are skewed. The relationship between androstenone and skatole is shown in Fig. 1.

Table 1. *Means and standard deviations (S.D.) of androstenone (ppm) and skatole (ppm) in backfat*

Substance	Mean	S.D.	Range
Androstenone	1.26	0.94	0.01-4.80
Skatole			
Boars	0.073	0.095	0.00-0.69
Gilts	0.024	0.018	0.00-0.06

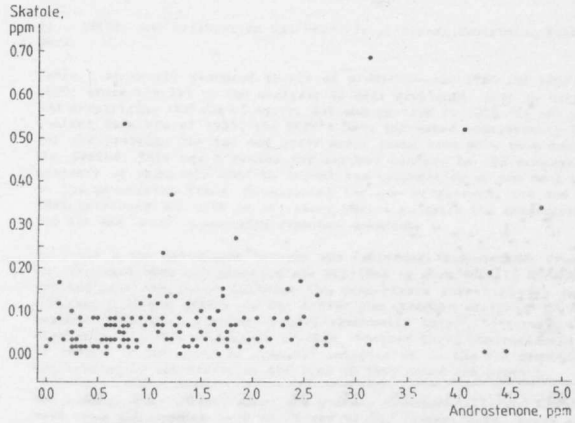

Fig. 1. Relationship between androstenone and skatole concentration in backfat.

The panel members

The panel members in the taint tests were chosen for their ability to repeat the same judgements on different occasions and to distinguish between fat samples from boars and gilts. For individual panel members, the correlation between taint test results and androstenone or skatole are given in Table 2. The correlations varied to a great extent between members, but in general the taint scorings were more strongly correlated to skatole than to androstenone.

Panel members 1, 2 and 3 took part in the sensory evaluation of meat.

Table 2. *Individual correlations between boar taint in backfat and androstenone or skatole for the members of the test panel*

Member	Androstenone	Skatole
1	0.45 ***	0.50 ***
2	0.38 ***	0.63 ***
3	0.17 n.s.	0.52 ***
4	0.60 ***	0.39 ***
5	0.08 n.s.	0.33 ***
6	0.13 n.s.	0.32 ***
7	0.34 **	0.25 *
8	0.29 ***	0.35 ***
9	0.34 **	0.61 ***
Mean	0.46 ***	0.69 ***

Level of significance: n.s.=not significant ($P>0.05$); *=$P\leq0.05$; **=$P\leq0.01$; ***=$P\leq0.001$.

Chemical versus sensory evaluation

The relationship between subjectively evaluated boar taint in backfat and levels of androstenone or skatole is shown graphically in Figures 2 and 3, respectively. The overall correlations between the traits studied are presented in Table 3. Skatole was quite strongly correlated with boar taint in fat (r=0.69), as well as with the meat scorings for taint, overall taste and bitter taste (r= 0.67; 0.57 and 0.49, respectively). A lower correlation was obtained between androstenone and boar taint in fat (r=0.46) and especially between androstenone and the meat variables (r=0.23, 0.34 and 0.29, respectively). The correlation between skatole and androstenone was 0.31. Many boars classified as having obviously or strongly tainted fat were also identified by the taste panel when scoring the meat.

Table 3. *Overall correlations between androstenone, skatole and the sensorially evaluated variables*

Variable	Androstenone	Skatole	Boar taint, backfat	Boar taint, lean meat	Overall taste	Bitter taste
Skatole	0.31 ***					
Boar taint, backfat	0.46 ***	0.69 ***				
Boar taint, lean meat	0.23 **	0.67 ***	0.55 ***			
Overall taste	0.34 ***	0.57 ***	0.50 ***	0.65 ***		
Bitter taste	0.29 ***	0.49 ***	0.47 ***	0.58 ***	0.81 ***	
Tenderness	0.23 **	0.01 n.s.	0.12 n.s.	0.08 n.s.	0.17 *	0.22 **

Level of significance: n.s.=not significant ($P>0.05$); *=$P\leq0.05$; **=$P\leq0.01$; ***=$P\leq0.001$.

Both linear and quadratic regressions were calculated with androstenone or skatole as independent variables and the sensorially evaluated traits as dependent variables. However, only the regression for boar taint on skatole had a quadratic component not far removed from significance level (P=0.07). Multiple regression analysis was performed to study how much of the variation in boar taint or taste could be attributed to androstenone and skatole alone or to the two combined (Table 4). For boar taint in backfat, androstenone alone accounted for 21% of the variation, while skatole alone accounted for 47%. The combination of androstenone and skatole increased the coefficient of determination to 54%. For the sensory evaluation of meat in particular, skatole alone accounted for much more of the variation than did androstenone. When combining the two variables, the effect of androstenone was even non-significant ($P>0.05$) for determining the taint level in meat.

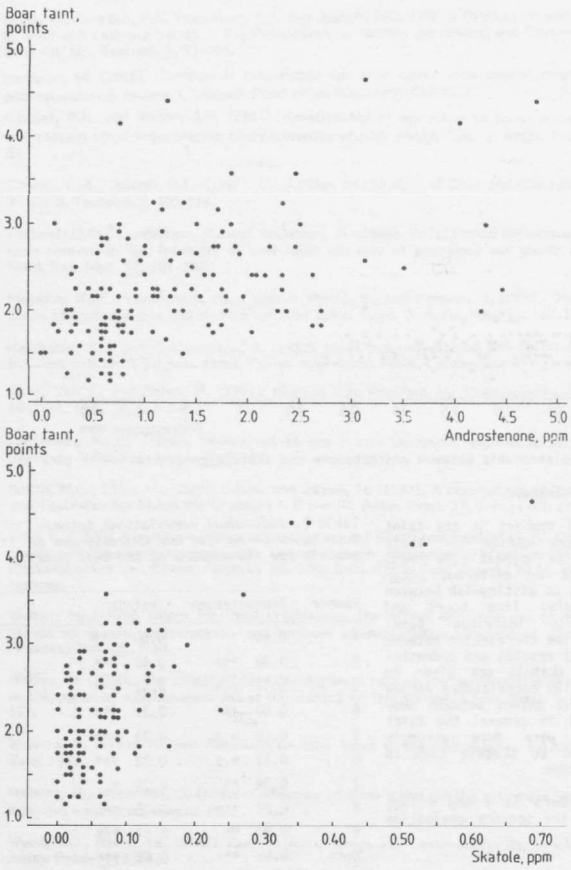

Figure 2 and 3. Relationship between boar taint intensity and (Fig. 2) androstenone concentration and (Fig. 3) skatole concentration in backfat.

The effect of litter and nutrient density level

Levels of significance for the effects studied in the analysis of variance are shown in Table 5. The litter effect was significant for androstenone ($P \leq 0.001$) as well as boar taint in backfat ($P \leq 0.05$), while the interaction between litter and nutrient density level was significant for skatole ($P \leq 0.01$) and boar taint in meat ($P \leq 0.05$). The skatole concentration was on average higher for pigs on the low nutrient density diet than on the high. The means and standard deviations (within parentheses) were 0.09 (0.13) and 0.06 (0.06) ppm, respectively.

Table 4. *Coefficients of determination (R^2) for boar taint in backfat and lean meat and overall taste and bitter taste in meat obtained by combining androstenone and skatole in a multiple regression analysis*

Dependent variable	Independent variables[a]	R^2, %
Boar taint, backfat	And	21.3
	Ska	47.0
	And + Ska	53.6
Boar taint, lean meat	And	5.5
	Ska	44.5
	And + Ska	44.5
Overall taste	And	11.3
	Ska	33.0
	And + Ska	35.7
Bitter taste	And	8.3
	Ska	24.4
	And + Ska	26.3

[a] And = androstenone; Ska = Skatole

Table 5. *Levels of significance for the effects studied*

Trait	Effect of: Litter	Density level	Litter x density level
Androstenone	***	n.s.	n.s.
Skatole	n.s.	*	**
Boar taint, backfat	*	n.s.	n.s.
Boar taint, lean meat	*	n.s.	*
Overall taste	n.s.	n.s.	n.s.
Bitter taste	n.s.	n.s.	n.s.
Tenderness	n.s.	n.s.	n.s.

Level of significance: n.s.=not significant ($P>0.05$); *=$P \leq 0.05$; **=$P \leq 0.01$; ***=$P \leq 0.001$.

Discussion

The skatole concentrations found in this study were very similar to those reported for Swedish pigs by Hansson et al. (1980), for both boars and gilts but the analytical methods were quite different, however. It was interesting too that no gilts with a high skatole concentration were found in either of the studies.

The correlation between androstenone and skatole was 0.31 in the present study. This can be compared with the higher correlation of 0.54 published by Hansson et al. (1980). In the present study, there were some samples with a low androstenone content but with a high skatole concentration, while there were other samples with a high androstenone level but with a skatole concentration near zero. Most samples, however, with high scores for taint intensity also had a high skatole content, and the risk of misjudging samples when a test is based on skatole analysis alone seems to be small. If there had been a larger number of samples with a high androstenone level without a corresponding high skatole level, the number of false-negative assessments might have been higher.

The present study has demonstrated a closer relationship between skatole and boar taint than between androstenone and boar taint in backfat and, to a still higher degree, in lean meat. This can be partly explained by the choice of panel members. Usually the members of a panel used for taint testing of boar meat are chosen for their ability to detect androstenone. It was, our experience however, that many persons are able to rank boar fat in correct order of boar taint intensity even if they were rather insensitive to androstenone. When selecting the panelists, we therefore had no absolute demands for sensitivity to androstenone. As can be seen from Table 2, the panel members were on average more sensitive to skatole than to androstenone. It is our belief that most people are sensitive to the smell of skatole, but only a limited number are very sensitive to the smell of androstenone. The same was assumed by Hansson et al. (1980).

The existence of bitter taste in meat from some boars has, as far as we know, not been reported before. In the present study, the sensory evaluation of meat can be regarded as a pilot study, due to the very limited number of members on the taste panel. We were very interested, however, to test if it was possible to find a relationship between the specific bitter taste found in some boar meat and androstenone or skatole, even with limited resources. Bitter taste was highly correlated to the overall taste and both estimates were more closely correlated to skatole than to androstenone. At the sensory evaluation of meat, we tried to identify the gilt sample at each testing occasion, but only seldom could all members succeed in achieving that consistently. It can thus be pointed out that even if it is possible to recognize boar taint and bitter taste in lean meat of some boars, most boar meat in the study could not be distinguished from gilt meat.

The significant effect of litter or interaction litter x diet, for androstenone, skatole and boar taint in both backfat and lean meat indicates a genetic component for all these traits. Selection for high and low androstenone content has been performed successfully, achieving a heritability of about 0.6, as reported by Willeke (1983). In another selection experiment, Jonsson & Andresen (1979) included boar taint intensity in addition to androstenone concentration and found a realized heritability of about 0.4.

Mortensen & Sørensen (1984) suggest 0.24 ppm skatole equivalents to be an optimal sorting level for excluding tainted carcasses. Had we applied that limit in our material, only 7 samples would have exceeded it. However, it is of interest that 5 of these samples came from pigs fed the low nutrient density diet. Skatole is formed in the digestive tract as a putrefaction product of tryptophan. An increased amount of crude fibre in the diet will stimulate the fermentative processes in the hind gut, as discussed by Just et al. (1983). This could also be an explanation for our results. The much higher level of skatole in boars than in gilts, however, indicates an interaction between androgen level and skatole metabolism.

It can be concluded that androstenone alone is a reasonably good predictor of boar taint presence in backfat. As androstenone is fat-soluble but not water-soluble, this substance does not determine the overall taste or bitter taste in meat from boars to any significant degree. Skatole is both fat- and water-soluble, and would thus appear to be a better determinant not only for boar taint in fat, but also for the overall taste and bitter taste in lean meat.

The Danish skatole assay is quickly done, and is therefore suitable for use as a screening method for detecting boar taint in large numbers of boars.

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