A COMPARISON OF THE OFF-FLAVOUR OF SHOULDER BUTTS FROM ENTIRE MALE AND FEMALE PIGS USING EXPERT AND CONSUMER PANELS

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SUMMARY

Boar taint has been mostly related to the levels of the compounds skatole and androstenone and there is an ongoing discussion as to whether one of these two compounds is the most important contributor to boar taint. In this study, sensory profiling was performed to compare the off-flavour of shoulder butts from entire male and female pigs using both expert and consumer panels and to relate it to the levels of skatole and androstenone.

Both the skatole and androstenone levels in boars had a significant effect on the off-flavour of shoulder butts, but they could only explain about 50% of the variation. The off-flavour of shoulder butts was relatively high, especially for entire males compared to gilts. Males with a high skatole content ($\geq$0.20 ppm) had on average only a slightly higher score for off-flavour than males with a low skatole content ($<$0.20 ppm). At a low skatole content, the shoulder butts still became tainted. In the sensory profiling, it was found that the attributes manure and stable were only explained by skatole, to 47% and 35%, respectively, whereas urine could be explained to 53% by both skatole and androstenone and their interaction. The percentage of consumers that did not approve of the flavour was higher for the entire males compared to the females. The possibility of rejection by consumers of meat from entire male pigs because of off-flavours cannot be eliminated for the boars with a low skatole content.

Introduction

The advantages of entire male pig production with high percentage lean and good feed efficiency (Malmfors and Lundström, 1983; Diestre et al., 1990) are counteracted by the sometimes occurrent off-flavour of the meat. This abnormal odour, commonly called boar taint, has been mostly related to the levels of the compounds skatole and androstenone (Hansson et al., 1980). There is an ongoing discussion as to whether one of these two compounds is the most important contributor to boar taint. Under Danish conditions, skatole in back fat seems to be the most important factor influencing taint. The correlation between boar taint intensity and skatole in back fat is close to 0.70 (Mortensen et al., 1986). Androstenone present in fat has also been identified as contributing to taint and, under the conditions of pork meat consumption in France, androstenone is more closely correlated to boar taint than skatole (Bonneau, 1992). Sensitivity to boar taint varies among consumers and countries. Human perception of androstenone is under genetic control (Wysocki & Beauchamp, 1984) and can differ in various consumer populations. The interrelationship between expert panels and consumer preferences has not always been good. Boars rated highly in taint by expert panels have not always been disliked by consumers (Malmfors et al., 1990). Shoulder butts are popular cuts in Sweden but they have been less studied with regard to boar taint, as opposed to *M. longissimus dorsi*. Moreover, sensory profiling was performed to evaluate whether different profiling of the off-odour of androstenone and skatole, could be obtained. The aim of this study was therefore to compare the off-flavour of shoulder butts from entire male and female pigs using both expert and consumer panels and to relate it to the levels of skatole and androstenone.

Materials and Methods

Pigs of a three-cross breed [(Landrace x Yorkshire) x Hampshire] were collected from three herds, 12 entire males, with the same skatole variation and 6 females per herd. The average carcass weight was 75 kg (67-84 kg) for the males and about 80 kg for the females. Samples of fat for the analysis of skatole and androstenone were collected from the neck region.

The fat skatole level was measured using the Danish spectrophotometric method, which is based on the colour reaction between paradimetylaminobenzaldehyde and indolic compounds (Mortensen & Sørensen, 1984). Androstenone (5-androst-16-en-3-one) in porcine adipose tissue was analysed using an RIA-radioimmunoassay method developed in Norway (Øysten Andresen, 1978).

Three groups of samples were established according to the level of skatole: group 1: 18 boars with skatole <0.20 ppm, group 2: 18 boars with skatole ≥0.20 ppm and group 3: 18 females.

The shoulder butts from both sides were vacuum-packed, after 3 days at +4°C and frozen until the time of sensory evaluation. One of the shoulder butts was evaluated by an expert panel and the other was used for consumer evaluation.

The intensity of the sensory attributes of whole oven-roasted (175°C) shoulder butts were cooked to an internal end-point temperature of 68°C and was judged by a trained panel of 12 members. The off-flavour was evaluated both in fat and meat. A sensory profile analysis was then performed, which involved the following attributes: pig, urine, manure, stable, naftaline, paints and terpentine, in the whole sample including both meat and fat. The panel members judged the intensity of the attributes of the hot samples (60°C), served in covered containers, on a continuous scale from 1 to 9, using the PSA system for registration (PSA, OPP Holland). 1 means no intensity and 9 means high intensity of the characteristic in question. Prior to sensory evaluation, the panel was trained using an ascending series of androstenone and skatole in fat.

50 consumers of pork tested samples from 27 (nine from each group) shoulder butts. Consumer tests were conducted at *Jordbrukets Provkök* in Stockholm. Samples of whole oven-roasted (175°C) shoulder butts, were cooked to an internal end-point temperature of 68°C and served hot (60°C) in covered containers. They were evaluated for the approval of aroma, flavour and overall acceptability, using a nine-point hedonic scale. Consumers did not approve of flavour of the meat when the score was lower than 4. Either the technical assistants or the consumers were informed that boars were among the samples.

Statistical analysis

Analysis of variance (ANOVA), Tukey's multiple comparison test, multiple regression and Principal Component Analysis (PCA) were performed using the SYSTAT, the system for statistics, 1990. The variations in the assessment of the off-flavour, due to the assessors' differing sensitivities, were not especially high or systematic. For that reason, the data was averaged over the 12 members of the panel and the two replicates before performing ANOVA, Tukey's test and PCA. The interrelationships between profile and consumer data were determined. Relating the consumer data and the scores from the sensory profiles, linear regression of the percentage of consumers that did not approve of the aroma or flavour and the two first principal components (which are normalized to variance 1) were used in a model:

$$Y_{aroma/flavour}=\beta_1 \cdot PC1+\beta_2 \cdot PC2 \qquad (1)$$

Results and discussion

The skatole and androstenone levels varied in the pig material from 0.05 to 0.60 ppm and from 0.10 to 7 ppm, respectively. The fat skatole and androstenone content was, as expected, very low in the females, about 0.06 ppm and 0.08 ppm, respectively. In the males the content of androstenone was on average 2 ppm in both skatole groups. At the low skatole content, <0.2 ppm, the fat androstenone content was even higher about 2.1 ppm mean score, than at the high skatole content, ≥0.2 ppm, with a mean score of about 1.8 ppm for this group of males. Evidently, no relationship between skatole and androstenone was observed in this study, r=0.2 n.s.. A positive significant relationship was observed between the androstenone content and the slaughter weight of male pigs (p=0.002, r=0.4). This shows the importance of keeping the slaughter weight low in order to reduce the risk of a high androstenone content.

Sensory evaluation of shoulder butts

The results of the sensory evaluation of off-flavour in meat and fat by the trained panel, divided into the three groups, are shown in Table 1. The off-flavour was relatively high (>3 is less acceptable), especially for entire males compared to gilts, and it was also significantly higher in meat than in fat. Males with a high skatole content had on average only a slightly higher score for off-flavour than males with a low skatole content. At a low skatole content, the shoulder butts still became tainted. One reason for this could be the high sensitivity of the assessors in the profile panel to boar taint. Contents of other compounds than skatole could be another reason for the unpleasant odour in these pigs. The ANOVA showed significant group and sex effects (p=0.000)

for the off-flavour in both meat and fat. The results of multiple regression analysis, according to a model consisting of skatole, androstenone and the combination skatole and androstenone, are shown in Table 2. Using this model, off-flavour in meat could be explained to no more than 45% by skatole ($p=0.02$) and androstenone ($p=0.09$) and to 48% in fat, which is similar to the results on *M. longissimus dorsi* (Hansson et al., 1980). The profiling included the attributes: pig, urine, manure, stable, naftaline, paint and terpentine and was performed by the same panel. The averaged responses over replicates and assessors were used for the multiple regression (Table 2) and PCA. Using multiple regression analysis, the attributes manure and stable were only explained by skatole, to 47% ($p=0.007$) and 35% ($p=0.04$), respectively, whereas urine could be explained to 53% by a model consisting of both skatole ($p=0.02$) and androstenone ($p=0.01$) and their interaction ($p=0.06$). The other attributes were not significantly explained by either skatole or androstenone.

PCA of the data gave four PCs, which described about 88% of the total variation within the shoulder butt samples. The first two principal components are presented in a score plot in Figure 1. Only the 27 samples which were evaluated by both an expert panel and the consumers are shown in the figure. The first component, describing 49% of the variation, separates the major part of the gilts from the males. The males have a higher intensity of urine, manure and stable than the gilts. The second component, describing 21% of the variation, separates the rest of the males from the gilts, mainly with respect to naftaline and paint. The attributes urine, manure, stable and naftaline, which describe the first two components, are thus mostly assignable to an entire male pig. It is interesting to note that naftaline and paint, which are typical attributes of an entire male pig, according to the PCA, are not explained significantly by either skatole or androstenone (Table 2).

Consumer test

The technical assistants, who prepared the samples of shoulder butts for the consumers, identified the males as tainted. Sholder butts of both low and high skatole content were rated high in taint. In the consumer test, the average percentage of consumers that did not approve of the aroma or the flavour of the meat were significantly higher for both the group of males with low and high skatole levels, as opposed to the females (Table 3). This shows the risks in classifying entire male pigs for approval by consumers through measuring only the skatole content. A positive significant relationship was observed between the percentage of consumers that did not approve of the aroma or the flavour and the skatole content ($r=0.68$, $p=0.001$ and $r=0.74$, $p=0.000$ respectively). The relationship with the androstenone content was lower ($r=0.59$, $p=0.04$ and $r=0.65$, $p=0.03$, respectively).

The arrows in Figure 1 show the relationship between the sensory data and the percentage of consumers that did not approve of the aroma or the flavour, respectively. The arrows point in the same direction and show a positive relationship between the percentage of consumers that do not approve of the aroma or the flavour and the high intensity of the attributes urine, manure, stable and naftaline describing the first two components, which could mostly be assigned to entire male pigs.The values of the ß-coefficients in model (1) for aroma were $ß_1=3.05$ and $ß_2=10.75$ and for the flavour $ß_1=6.03$ and $ß_2=10.68$, respectively.

Conclusion

Both the skatole and the androstenone levels in boars have a significant effect on the off-flavour of shoulder butts, but they could only explain about 50% of the variation. The off-flavour of shoulder butts was relatively high, especially for entire males compared to gilts. Males with a high skatole content ($\geq$0.20 ppm) had on average only a slightly higher score for off-flavour than males with a low skatole content ($<$0.20 ppm). At a low skatole content, the shoulder butts still became tainted. In the sensory profiling, it was found that the attributes manure and stable were only explained by skatole, to 47% and 35%, respectively, whereas urine could be explained to 53% by both skatole and androstenone and their interaction. The percentage of consumers that did not approve of the flavour was higher for the entire males, compared to the females. The possibility of rejection by consumers of meat from entire male pigs, because of the off-flavours, cannot be eliminated for boars with a low skatole content.

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Figure 1.PCA scores for PC1 and PC2 for the sensory profile on shoulder butt samples, average of two replicates and 12 assessors. _, males with skatole content <0.20 ppm; , males with skatole content ≥0.20 ppm; O, gilts. The arrow directions show the relationship between consumer and sensory profiling attributes, n=27 samples, 50 consumers.