Boar taint reduction in smoked, cooked ham

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***Abstract* — In order to clarify whether cooking temperature during processing and serving temperature affect the perceived boar taint in smoked, cooked ham, 30 carcasses from entire male pigs (skatole equivalents = 0.25 ppm - 0.50 ppm) and 30 barrows were selected. Androstenone, skatole and indole (ASI) were analysed on neck fat samples using HPLC. Topsides (M. semimembranosus) were cured, smoked and heat-treated to five different core temperatures ranging from 70°C to 90°C. The hams were stored at 0°C for 14 days before sensory analysis and reheated to either 23°C or 65°C before serving. Boar taint-related sensory attributes in the hams were strongly affected by serving temperature and androstenone, but no effects of skatole, indole and core temperature were observed. Pungent odour/flavour, sweaty odour and urine odour were the sensory attributes most affected by androstenone and serving temperature.**

Keywords—**Boar taint, cooking, serving temperature**

INTRODUCTION

Castration of male piglets is expected to be prohibited in Denmark in the near future. It is therefore important to gain more knowledge about how to process the boar-tainted meat to eliminate the unpleasant odour. Boar taint is caused by the presence of skatole, which is associated with the odour of faeces or naphthalene, and androstenone, which is associated with the odour of urine and sweat. Which of these two compounds is the most important contributor to boar taint is a subject of much debate. Threshold values of 0.2 µg/g skatole and 0.5-1.0 µg/g androstenone in fat tissue are regarded as the concentrations above which consumers are likely to react adversely to the compounds (Lundström et al, 2009).

Androstenone and skatole are volatile compounds, and their concentration is therefore expected to decrease when the meat is heat-treated during processing and cooking (Bonneau et al., 1994; Denhard et al., 1995). Because of its lower volatility, androstenone is expected to have a greater effect on the sensory profile than skatole in cooked meat (Bañón et al., 2003). More is known about fresh pork than processed meat products, but it has been established that processing makes tainted meat more acceptable (Walstra, 1974). However, the effect of cooking has been shown to depend on the cooking temperature, because of the differences in volatility between skatole and androstenone. When cooking fresh pork to 68°C, the flavour profile is affected mostly by skatole, whereas flavours related to androstenone are most pronounced when cooking to 80°C. Whereas, sensory profiles of cooked ham (68°C and 80°C) are explained by skatole, androstenone and the interaction (Agerhem & Tornberg, 1995).

The objectives of this work were to clarify whether cooking temperature during processing of smoked, cooked ham affected the perceived boar taint and to clarify the effect of serving temperature.

MATERIALS & METHODS

At a local slaughterhouse, boars were screened using the Danish skatole method, and 30 carcasses with skatole equivalents of between 0.25 ppm and 0.50 ppm were selected and also 30 barrows as references. Samples from the neck fat were analysed for skatole, indole and androstenone using HPLC. Topsides (M. semimembranosus) were cured and smoked according to a standard recipe and cooked to five different core temperatures: 70°C, 75°C, 80°C, 85°C and 90°C (6 pigs x 2 sides = 12 samples per temperature). The hams were stored at 0°C for 14 days before sensory analysis and reheated in a water bath to either 23°C or 65°C before serving.

A. ASI content

The androstenone, skatole and indole levels (ASI) were determined on neck fat samples using HPLC, according to a modified Hansen-Møller method (1994). For the calculation, 0.1 ppm androstenone and 0.015 ppm skatole were substituted for values below the limit of quantitation.

B. Sensory analysis

The hams were evaluated by a professional and trained sensory panel consisting of 9 assessors at the Danish Meat Research Institute (DMRI). All assessors had participated in training in accordance with ISO 8586-1, ASTA STP758 and Claudi-Magnussen et al., (2011).

From each ham, 10-mm-thick slices were cut and packaged in PE bags before being reheated in 23°C or 75°C water. After 45 minutes' reheating, each slice was cut into two samples (3 x 5 cm) and placed in a petri dish with a lid on. Samples served hot were placed on pre-heated plates, whereas plates for serving cold were room temperature. Actual serving temperatures were measured to approximately 23°C (cold) and 65°C (hot).

The hams were evaluated in 8 sessions on a 15-point unstructured scale anchored at the extremes (0 = low intensity and 15 = high intensity). The evaluated odour attributes were: intensity of ham, smoke, acid, sweet, stale, pungent, sweaty, urine and manure. The evaluated taste attributes were: intensity of acid, salt and sweet. The evaluated flavour attributes were: intensity of ham, smoke, stale, pungent, sweaty, urine, manure, piggy and chemical flavour.

Statistical analysis

The following attributes had low Chronbachs alpha values (< 0.8) and were excluded before further statistical analysis: ham odour, smoked odour, acid odour, sweet odour, manure odour, acid taste, salt taste, sweet taste and ham flavour, smoked flavour, stale flavour, manure flavour, piggy flavour and chemical flavour.

The data were analysed using Proc Mixed in SAS (v9.2., Cary, NC, USA.).

The following model was used to predict boar taint in smoked, cooked hams:

$$Y = \mu + T\_process + T\_serv + androstenone + skatole + T\_process*T\_serv + T\_process*S + T\_process*A + T\_serv*S + T\_serv*A + T\_process*T\_serv*A + T\_process*T\_serv*S + \varepsilon$$

Y is the sensory attribute (average for all sensory assessors), and processing temperature (T_process), serving temperature (T_serv), androstenone level (A) and skatole level (S) are continuous variables analysed as fixed effects. Indole was excluded from the model because of a strong correlation with skatole in these data.

The "acceptance level" for each sensory attribute is defined as the mean for barrows + 2 standard deviations.

RESULTS

ASI analysis

Androstenone, skatole and indole levels in neck fat from entire males pigs varied between 0.10 and 3.5 ppm, 0.015 and 0.51 ppm, and 0.015 and 0.564 ppm, respectively (Figure 1). Androstenone, skatole and indole levels in the barrows varied between 0.00 and 0.266 ppm, 0.015 and 0.231 ppm, and 0.015 and 0.131 ppm, respectively.

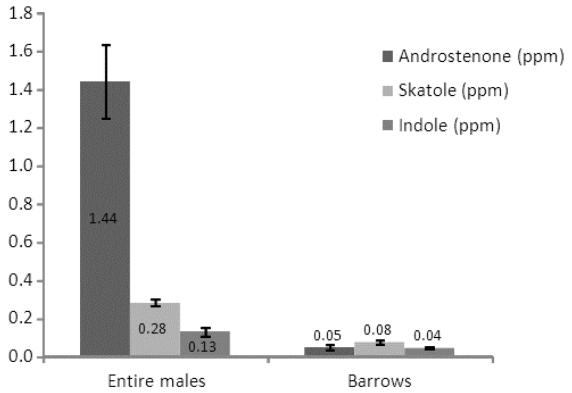

Figure 1. Androstenone, skatole and indole levels and SEM values in neck fat from entire male pigs and barrows.

Indole was highly correlated to skatole and was therefore omitted from the data analysis. As seen in Figure 2, androstenone and skatole were only slightly correlated (r = 0.245), which is in agreement with Hansen-Møller (1974) (0.365).

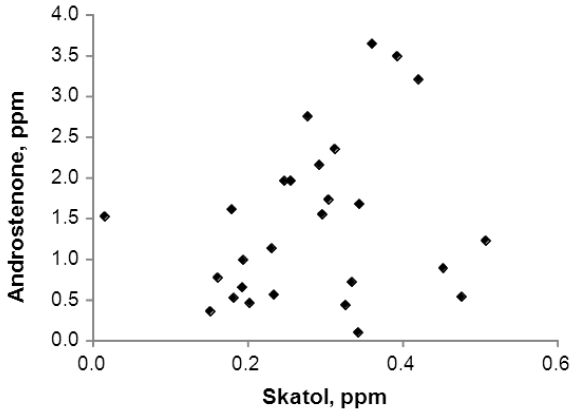

Figure 2. Androstenone, skatole and indole levels in neck fat from entire male pigs and barrows.

Effect of temperature and ASI on sensory attributes

Boar taint-related sensory attributes in the smoked, cooked hams were strongly affected by serving temperature and androstenone, but no effects of skatole, indole and processing temperature were observed (Table 1).

Table 1. Levels of significance. Effect of skatole (ppm), androstenone (ppm), processing temperature (70-90°C), serving temperature (cold - hot) and A*T_serv interaction of smoked, cooked ham from entire males.

	Attributes	Skatole	Androste-none	Process temp	Serving temp	An*Serv
	Stale	Ns	Ns	Ns	Ns	Ns
Odour	Pungent	Ns	<0.0001	Ns	Ns	<0.0001
Odour	Sweaty	Ns	<0.0001	Ns	Ns	<0.0001
Odour	Urine	Ns	<0.0001	Ns	0.03	<0.0001
Flavour	Pungent	Ns	<0.0001	Ns	0.005	Ns
Flavour	Sweaty	Ns	<0.0001	Ns	Ns	Ns
Flavour	Urine	Ns	<0.0001	Ns	0.02	Ns

Pungent odour, sweaty odour, urine odour, and pungent flavour were the sensory attributes most affected by androstenone and serving temperature. Sweaty flavour was the only attribute only affected by the androstenone level in the neck fat.

As shown in Table 2, all odour attributes can be eliminated when serving ham cold (23°C), but boar taint-related flavours will appear when the meat is chewed, depending on the androstenone level. To eliminate all boar taint-related flavours, entire male pigs with androstenone levels (neck fat) above 0.4 ppm cannot be used.

Pungent flavour is the most intense flavour within the sensory profile, but it also has the highest acceptance level (barrow mean + 2sd) and therefore it is not the most critical attribute. In contrast, the most critical attributes for cold serving are sweaty and urine flavour.

Table 2. Effect of androstenone level and serving temperature (hot, cold) on sensory attributes related to boar taint. B accept= barrow mean + 2sd (acceptance level). Coloured cells indicate products with acceptable levels of boar taint.

	Androstenone (ppm)	Pungent odour	Sweaty odour	Urine odour	Pungent flavour	Sweaty flavour	Urine flavour
Hot	0.0	1.7	1.1	1.5	2.4	1.3	1.7
Hot	0.2	1.9	1.3	1.7	2.6	1.5	2.0
Hot	0.4	2.1	1.5	1.9	2.7	1.7	2.2
Hot	0.6	2.3	1.6	2.1	2.9	1.9	2.5
Hot	0.8	2.4	1.8	2.3	3.1	2.2	2.8
Hot	1.0	2.6	2.0	2.5	3.3	2.4	3.0
Hot	1.2	2.8	2.2	2.7	3.5	2.6	3.3
Hot	1.4	3.0	2.4	2.9	3.6	2.9	3.6
Hot	1.6	3.2	2.6	3.2	3.8	3.1	3.8
Hot	1.8	3.4	2.8	3.4	4.0	3.3	4.1
Hot	2.0	3.6	3.0	3.6	4.2	3.5	4.4
Hot	B accept	2.1	1.4	1.8	2.6	1.7	2.0
Cold	0.0	1.3	0.7	0.7	1.8	1.3	1.1
Cold	0.2	1.3	0.7	0.7	2.0	1.5	1.4
Cold	0.4	1.3	0.7	0.7	2.2	1.7	1.7
Cold	0.6	1.3	0.7	0.7	2.4	1.9	1.9
Cold	0.8	1.3	0.7	0.7	2.5	2.2	2.2
Cold	1.0	1.2	0.7	0.8	2.7	2.4	2.5
Cold	1.2	1.2	0.7	0.8	2.9	2.6	2.7
Cold	1.4	1.2	0.7	0.8	3.1	2.9	3.0
Cold	1.6	1.2	0.7	0.8	3.3	3.1	3.3
Cold	1.8	1.2	0.7	0.8	3.4	3.3	3.5
Cold	2.0	1.2	0.7	0.8	3.6	3.5	3.8
Cold	B accept	2.5	1.0	1.1	2.9	1.7	1.9

If ham is reheated (65°C) before serving, the boar taint will be more pronounced compared with cold serving (23°C). Both boar taint-related odours and flavours can be perceived in the ham. To avoid sweaty odour, urine odour, pungent odour and urine flavour, meat from male pigs with androstenone levels in the neck fat above 0.4 ppm should not be used.

Nevertheless, it is important to point out that this acceptance is an 'assessor acceptance level' and should not be mistaken for 'consumer acceptance', which could be higher.

CONCLUSIONS

Processing temperatures above 70°C have no effect on perceived boar taint in smoked, cooked ham. However, androstenone and serving temperature have a major effect. The androstenone level in the neck fat should be below 0.4 ppm and smoked, cooked ham should be served cold to minimise perceived boar taint. Variation in skatole levels is not reflected in boar taint in this product.

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