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SCREENING OF ORGANIC ENTIRE MALES

TRIAL REPORT NO. 955

Rejection rates due to boar taint are high among organic entire males and vary greatly between herds. Research showed that if rejection was based on skatole, 18% were rejected, and if also based on “Human nose” 26% were rejected.

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Abstract

Many organic entire male pigs produced in Denmark are rejected at slaughter due to boar taint. Research demonstrated that if rejection was based on skatole levels (>0.25 ppm), 18% of the male pigs were rejected, and if rejection was also based on the Human nose method, 26% of the male pigs were rejected. If androstenone levels were also included in the evaluation, rejection rates reached 68%.

Entire males from six organic herds were slaughtered and carcasses were subject to analysis of skatole and to the Human nose method at the slaughterhouse. In addition, skatole, indole and androstenone were analysed at a laboratory. To ensure that pork is free of boar taint, it will be necessary to analyse for both skatole and androstenone in the future. Today, pigs weigh more and are therefore closer to sexual maturity at slaughter than they were years ago. Organic male pigs grow

more slowly, are older at slaughter and are fed a different type of diet than conventional pigs, and they are therefore expected have higher levels of skatole as well as androstenone.

If the limit for rejection at the slaughterhouse is 0.25 ppm for skatole, averagely 18% - varying from 4% to 27% - of organic entire males will be rejected. If also the Human nose method is applied, rejection rates averaged 26% varying from 10% to 39%. Today, male pigs from conventional farms are rejected at slaughter due to skatole levels above 0.25 ppm, but for these farms it is still profitable to produce entire males as they can do so with fairly low rejection rates (4-5%).

If rejection is based on skatole and androstenone (skatole >0.25 ppm; androstenone >1.00 ppm), 68% of the organic entire males would be rejected.

The correlation between skatole analysed at the slaughterhouse and at a laboratory was close to 100%, which confirms identical outcome of both methods. The correlation between the Human nose method and skatole levels shows that the Human nose method accounts for approx. 60% of the variation in skatole and approx. 50% of the variation in androstenone levels.

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Background

Organic pig production is a niche production, which needs to focus increasingly on economy, animal welfare and productivity. Furthermore, the desire to cease castration as soon as possible also poses a challenge to the industry. Research is therefore required into how to reduce rejection rates among organic entire males, as organic pig producers wish to be able to produce entire males with low rejection rates (< 5%). Rejection rates for entire males from conventional farms (approx. 1% of all pigs) vary from 4% to 5% based on skatole, and these farms are only allowed to have a male pig contract because they have such low rejection rates.

Boar taint primarily comes from skatole, which is produced in the intestine and androstenone, which produced in the testicles. Both substances are decomposed in the liver, and the fraction that is not decomposed in the liver is deposited in the fatty tissue. Boar taint mainly comes across when meat is cooked, but not all humans are able to perceive it. In the 1980s and 1990s, online equipment was developed in Denmark for recording of skatole equivalents. This is a spectrophotometric method using luminous reflectance to measure skatole and indole expressed in the skatole equivalent. In the 1990s

when pigs were lighter at slaughter than they are today, research documented a strong correlation between skatole levels and boar taint evaluated by consumers and taste panels. To ensure that future production of entire males that are older/heavier at slaughter can be a realistic possibility in the future, as androstenone will also be important to boar taint, analysis equipment must be able to analyse for skatole as well as androstenone. Today, androstenone can only be detected at laboratories with the HPLC method that also determines skatole and indole. The HPLC method is far too expensive and too slow for online use at a slaughterhouse.

In Germany and the Netherlands, entire males are rejected on the basis of the Human nose method where a person placed by the slaughter line smells the fat on the carcass heated with an instrument similar to a soldering iron. In Denmark, an extended version of the Human nose method based on heating fat in flasks with boiling water was developed for use at the laboratory of a Danish slaughterhouse. To ensure that pork from organic entire males is free of boar taint, rejection of entire males in Denmark is based on both skatole levels and the Human nose method.

The aim of this trial was to investigate the rejection levels among entire males in organic pig production based on skatole and androstenone levels as well as the Human nose method. Furthermore, the trial included a comparison between the different methods available for analysis of boar taint.

Material and method

The trial comprised a total of 296 entire males from six organic farms (minimum 50 entire males from each farm). The pigs were slaughtered at the slaughterhouse in Herning where samples of fat were collected for analysis of boar taint. At the slaughterhouse, slaughter weight and lean meat percentage were recorded.

Samples of fat were subject to analysis for boar taint according to the below methods:

- At the slaughterhouse in Ringsted:
  a) Skatole determined online (ppm) [2].
  b) Boar taint determined with the Human nose method [1] according to the below scale:
     i) 0 = no boar taint
     ii) 1 = slight boar taint
     iii) 2 = boar taint
- At the lab of the Danish Meat & Research Institute, samples were subject to analyses of skatole, indole and androstenone using HPLC equipment [3]. For conversion to skatole levels (recorded at the slaughterhouse), the following equation is applied:
  Skatole level = 44.2*indole + 75.9*skatole + 0.027 [2]

Rejection rates were calculated on the basis of the analysis methods used (table 1).

Table 1. Analysis methods and rejection limits.

Method		Unit	Rejection limit	Reference
Slaughterhouse, 2012	Skatole	ppm = mg/kg	> 0.25	[1]
	Human nose	Score 1, 2, 3	= 2	[1]
Laboratory, HPLC	Skatole level*	ppm = mg/kg	> 0.25	[1]
	Indole	ppm = mg/kg	-	[1]
	Androstenone	ppm = mg/kg	> 1.00	[5]

* Skatole level (rejection limit) is calculated on the basis of skatole and indole: Skatole level = 44.2*indole + 75.9*skatole + 0.027.

Internationally, scientists are discussing the limit for rejection based on androstenone. Currently, two levels are being discussed: > 1.00 ppm and > 0.50 ppm androstenone [5].

The pig producers in the trial were asked to deliver pigs for slaughter at the optimum slaughter weight for organic pigs (75.0- 92.9 kg). Entire males were slaughtered every other week to maintain a reasonable number of pigs per slaughter round. The pigs were slaughtered in summer and autumn 2011. The pigs in the trial were delivered for slaughter over a long period of time due large weight variations on organic farms. In addition, some farms experienced disease outbreaks, and as a consequence growth slowed and pigs were delivered for slaughter over a longer period than intended.

When the first pigs were delivered for slaughter, a technician from Pig Research Centre was present and recorded a range of production conditions on the farms (appendix 1).

Statistics

Data were subject to analysis of variance, and all data were tested for effect of farm. Statistically significant differences are stated at 5 % level. A correlation analysis was made for the relation between the different analysis methods for boar taint, and it was tested whether the variation in androstenone might be explained by slaughter weight corrected for farm variation.

A linear model was calculated for the correlation between the Human nose method and skatole and androstenone levels.

Results and discussion

Slaughterhouse

A significant difference was found in weight and lean meat percentage between the farms (table 2). Skatole levels for all pigs averaged 0.18 ppm recorded at the lab at the slaughterhouse, and 18% of the pigs were rejected with a skatole equivalent above 0.25 ppm. The Human nose method resulted in an average score of 0.7, and with this method alone, 24% of the male pigs were rejected (score = 2) (table 2). If both the analysis of skatole and the Human nose score were included, 26% of the entire males would be rejected. More male pigs are rejected with the Human nose method than when rejection is based on skatole equivalents. Rejection rates differed significantly between the farms. Farm 4 had significantly lower rejection rates than the other farms where rejection rates were 2-4 times higher.

Table 2. Skatole levels, Human nose score and rejection rates, and weight and lean meat % recorded at the slaughterhouse.

Farm	1	2	3	4	5	6	All	Signifi-cance
Entire males	48	46	46	52	49	55	296	-
Slaughter weight	83.3^{b}	78.3^{c}	84.9^{ab}	82.9^{b}	77.6^{c}	85.8^{a}	82.2	P < 0.001
Lean meat %	56.1^{e}	60.2^{ba}	60.7^{a}	58.8^{c}	57.9^{d}	59.3^{bc}	58.8	P < 0.001
Skatole equivalent ppm	0.26	0.13	0.22	0.13	0.22	0.15	0.18	P = 0.07
Human nose	0.7^{ab}	0.4^{b}	0.8^{a}	0.4^{b}	1.0^{a}	0.8^{a}	0.7	P<0.001
Rejection rate, skatole > 0.25 ppm	27^{a}	15^{ab}	26^{a}	4^{b}	20^{a}	16^{ab}	18	P=0.0318
Rejection rate, Human nose = 2	23^{ab}	13^{b}	28^{ab}	10^{b}	39^{a}	25^{ab}	24	P=0.0077
Overall rejection rate, slaughterhouse (skatole>0.25ppm + Human nose= 2 (%))	29^{a}	22^{ab}	32^{a}	10^{b}	39^{a}	25^{ab}	26	P=0.2277

a,b,c,d,e,: Values with different superscripts within row are significantly different (p<0.05).

HPLC analyses of skatole, indole and androstenone revealed a significant difference between farms (table 3). If skatole and indole levels recorded with the HPLC equipment are converted to skatole equivalents, the values are the same as those recorded online at the slaughterhouse.

The organic pigs had an average androstenone level of 2.3 ppm, which is higher than the level (1.0 ppm) found in a previous study with conventional pigs [4].

If the rejection limit for androstenone was 1.0 ppm, 66% of the organic entire males would be rejected. This figure increases to 93% if the rejection limit is 0.5 ppm androstenone.

Another study demonstrated that androstenone levels increased significantly with slaughter weight (and thereby age) for conventional pigs with similar growth rates. Entire males weighing 75 and 95 kg, respectively, had an androstenone level of 1.23 and 1.72 ppm, respectively. Rejection rates would in this case be 58 and 78%, respectively [6].

Table 3. Skatole, indole and androstenone (HPLC analyses), calculated skatole (ppm) and rejection rate.

Farm	1	2	3	4	5	6	All, av.	Signifi-cance
Entire males	48	46	46	52	49	55	296	-
Skatole, ppm	0.28^{a}	0.10^{c}	0.22^{ab}	0.10^{c}	0.20^{ab}	0.15^{bc}	0.17	P=0.005
Indole, ppm	0.04^{bc}	0.02^{c}	0.04^{abc}	0.02^{c}	0.06^{ab}	0.08^{a}	0.04	P=0.002
Calculated skatole, ppm	0.25^{a}	0.11^{b}	0.21^{a}	0.11^{b}	0.20^{ab}	0.18^{ab}	0.18	P=0.009
Androstenone	2.87^{ab}	1.02^{c}	3.11^{a}	1.01^{c}	2.28^{b}	3.51^{a}	2.3	P<0.0001
Rejection rate, calculated skatole > 0.25 ppm	27^{a}	13^{ab}	23^{a}	4^{b}	22^{a}	16^{ab}	18	P=0.0287
Rejection rate, androstenone > 1.00 (>0.50)	75^{b} (98)	37^{c} (85)	89^{ab} (98)	21^{d} (79)	80^{ab} (98)	95^{a} (98)	66 (93)	P<0.0001
Overall rejection rate (skatole >0.25 and androstenone >1.0)	77^{b}	46^{c}	89^{ab}	21^{d}	80^{ab}	95^{a}	68	P<0.0001

a,b,c,d,e,: Values with different superscripts within row are significantly different (p<0.05).

Correlations

All correlations between boar taint substances were significant (table 4).

- Skatole equivalents recorded at the slaughterhouse and calculated on the basis of skatole and indole analysed with the HPLC equipment had a significant correlation of 0.97.
- The correlation between skatole equivalents recorded at the slaughterhouse and analysed skatole levels (HPLC) was 0.97.
- The best correlation between androstenone and skatole was obtained between calculated skatole and androstenone (0.62), whereas the correlation to skatole equivalent determined at the slaughterhouse and androstenone was lower (0.54).
- The correlation between Human nose and the skatole equivalent calculated and recorded at the slaughterhouse, respectively, was 0.59 and 0.57, respectively.
- The correlation between Human nose and androstenone was 0.49, which is significant.

Table 4. Correlations between boar taint determined with different methods (all values are significant p<0.0001).

	Skatole equivalent, slaughterhouse	Skatole (HPLC)	Skatole, calculated (HPLC)	Androstenone (HPLC)	Human nose
Skatole equivalent, slaughterhouse	1.00	0.97	0.97	0.54	0.57
Skatole (HPLC)	0.97	1.00	0.99	0.60	0.57
Skatole, calculated (HPLC)	0.97	0.99	1.00	0.62	0.58
Androstenone (HPLC)	0.54	0.60	0.62	1.00	0.49
Human nose	0.57	0.57	0.59	0.49	1.00

The correlation between the Human nose score and skatole and androstenone levels can be described with a linear model:

Human nose score = 0.20 + 1.63*skatole equivalent (ppm) + 0.08*androstenone (ppm)

where both skatole and androstenone levels contribute significantly to explaining the Human nose score ($p<0.05$).

Analyses showed no correlation between slaughter weight and androstenone level regardless of whether correction was included for differences between farms.

Description of farms

In a previous study with entire males, conditions at farm level that may increase the risk of the pigs being rejected at slaughter were investigated [7]. The conditions on the farms in this trial (appendix 1) were correlated to the knowledge obtained in the previous study.

- High slaughter weight and age may lead to development of androstenone as the pigs approach sexual maturity. It is not known whether the onset of maturity is triggered by age, weight or the two combined.
    - i) In this trial, slaughter weight varied between the farms. Farms 2 and 5 had the lowest slaughter weight, but only farm 2 had low average androstenone levels. Farm 1, which had high average androstenone levels, developed health problems in the delivery period, wherefore some of the pigs were considerably older at slaughter than planned. Pigs that grow slow due to disease may have a low slaughter weight even though they are fairly “old”, and they may therefore have a high androstenone level.
    - ii) Daily gain was relatively low (not all farms in the trial recorded daily gain) compared with conventional farms [8]. A low daily gain may lead to increased androstenone levels as pigs are older and closer to maturity at the time of slaughter.

- Dirty pigs: High risk of increased skatole level.
    i) On farms 3 and 6, the pigs risked becoming dirty. On farm 3, average skatole levels were high, but low on farm 6. Whether the pigs were actually dirty upon delivery for slaughter was not recorded.
- Housing the pigs according to gender may reduce boar taint on farms with these problems, but there is no evidence that the method reduces boar taint. When entire males are housed with female pigs, maturity may set in earlier than normal and thereby boar taint will develop, particularly from androstenone.
    i) On farms 2, 3 and 6, pigs were not housed according to gender. Farm 2 had low average androstenone levels, and farms 3 and 6 had the highest average androstenone levels.

Conclusion

If the rejection limit used for boar taint is based on skatole equivalents (>0.25 ppm), rejection rates averaged 18%, and if the Human nose method was included, rejection rates averaged 26%. If rejection was based on skatole equivalents above 0.25 ppm and on androstenone levels above 1.00 ppm, 68% of all organic entire males were rejected at the slaughterhouse. The Human nose method alone is not sufficient to reject entire males with boar taint if androstenone levels above 1.00 ppm are assumed to trigger boar taint.

With the rejection rates found in this screening, it is not a financially attractive option to produce organic entire males. More knowledge on how to reduce rejection rates based on boar taint in the future is required.

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Trial no. 1138

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Appendix 1

General farm data

Farm	1	2	3	4	5	6
Finishers/year	2000	3000	1800	6000	2000	4000
Sows	150	200	100	300	190	210
Weight at insertion, kg	13	7	17.5	14.5	11.5	12
Weight at insertion, kg	27.5	13	55	37	34	30
Age at slaughter	180	180	175	180	140	195
Slaughter weight, kg	82.8	84	-	84	84	84
Daily gain, g	-	-	650 (14-110 kg)	488 (13-40) 843 (40-110)	551(14-37) 993 (38-109)	650 (12-105)
Feed conversion, FUgp/kg	-	3.0 from 13 kg	3.2 from 14 kg	3.0 from 13 kg	2.76	3.3 from 12 kg

Feeding

Farm	1	2	3	4	5	6
Feed mixed on-farm	Yes	Yes	Yes	Yes	Yes	Yes
Dry feed	Yes	Yes	Yes	Yes	Yes	Yes
Ad libitum	Yes	Yes	Yes	Yes	Yes	Yes
Adjustment of feeder	Every week	No	Every week	Every week	No	Every week
Number of diets	1	2	1	2	1	1

Accomodation

Farm	1	2	3	4	5	6
Batch	Yes	No	Yes	Yes	No	Yes
Weight spread	-	-	Max. 15 kg	10 kg	-	Up to 20 kg
Sorted according to size	Yes	-	Yes	Yes	No	Yes
Housed according to gender	Yes	No	No	Yes	Yes	No
Wash	No	No	Yes	No	No	No
Pigs per pen	60	40	35	18-22	18/40	20
Slats in outdoor area	0	50%	?	45%	$10m^2$	-
Well-defined dunging area outdoors	No	Yes	No	No	No	Yes
Dirty pigs	Yes	No	No	Yes	No	No
Time in pick-up facility	12-14 hrs	-	30 min.	1 hr	Max. 1 hr	11-20 hrs
Fasting before pick-up	12-14 hrs	0	12 hrs	12 hrs	0	11-20 hrs
Transport time	5-8 hrs	15 min.	2 hrs	3 hrs	?	4 hrs
Risk of pigs becoming dirty	No	-	Yes	No	-	Yes

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