

# Reducing the Incidence of Boar Taint in Irish Pigs





# REDUCING THE INCIDENCE OF BOAR TAIN IN IRISH PIGS

## Authors:

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Paul Allen B.Sc. M.Sc. Ph.D.

Robin Joseph B.Sc. M.Sc. Ph.D.

**The National Food Centre**

**Teagasc, Dunsinea, Castleknock, Dublin 15**

**and**

Brendan Lynch M.Agr.Sc. MS

**Moorepark Research Centre, Fermoy, Co. Cork**

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## SUMMARY

Boar taint is an unpleasant odour that is released during cooking from some pork and products made from the meat and fat of non-castrated male pigs. Only a proportion of boars produce this odour and not all consumers are sensitive to it. Nevertheless it is a potential problem for the industry since an unpleasant experience can mean that a sensitive consumer may not purchase pork or pork products again. Some European countries are very concerned about this problem and most castrate all the male pigs not required for breeding. Irish pig producers ceased castration more than 20 years ago because boars are more efficient converters of feed into lean meat and a research study had shown that boar taint was not a problem at the carcass weights used in this country at that time.

Since carcass weights have increased considerably in the last 10 years or so it was decided to determine the incidence of boar taint in the present population. In a sample of 340 belly fats taken from 7 export factories in 1997 the incidence was found to be about 8%, the same as found in another survey a few years previously. The relationship with carcass weight was weak so it is not surprising that the incidence had not increased between these two surveys. Two of the factories had much higher than average incidences. An investigation of the causes of these differences might reveal production factors that affect the incidence of boar taint.

Since other research has shown that some production factors affect the incidence of boar taint, a trial was undertaken to examine the effect of a number of these factors collectively on the incidence. The lowest incidence of boar taint was found when boars were mixed with gilts on fully-slatted floors and fed a reduced protein diet containing virginiamycin (not permitted in the EU for use in pig feed since 2000), using a wet feeding system. Producers are recommended to implement these husbandry practices as far as possible in order to reduce the incidence of boar taint.

A practical method of screening for boar taint on the slaughterline would be useful for segregating out problem carcasses. Such a method does not exist so a trial was carried out to examine whether the size of the sexual organs could



be used as an indirect indicator of boar taint. There was no correlation between the incidence of boar taint and any of these possible indicators.

Sniff panels are the accepted means of identifying tainted fat samples, but these are difficult and expensive to run. Chemical analysis to quantify the concentrations of the two main compounds implicated in boar taint is very specialised and expensive. An attempt was therefore made to develop an objective method of identifying tainted samples using an electronic nose. This attempt was unsuccessful but the possibility of developing such a method in the future is not ruled out.

▶  
*An electronic nose was investigated as a potential objective method of identifying boar taint.*





## INTRODUCTION

Sometimes when pork or pork products are cooked there is an odour that some consumers find objectionable. This is commonly known as boar taint as it is only found in the meat of entire male pigs. Not all boars produce meat with boar taint and not all consumers are sensitive to it. The incidence of boars in a population with the characteristic taint depends on many factors and therefore varies from population to population. Most studies have found that the incidence is between 5 and 15 %. Research has also shown that women are more likely to be sensitive to the odour than are men, the proportions of sensitive individuals being about 1 in 2 women and 1 in 7 men. Two compounds are mainly responsible for the offensive odour, androstenone, a male steroid, and skatole, a product of the bacterial degradation of the amino acid tryptophan in the gut. Both of these compounds become deposited in the fat and are released during cooking.

Castration solves the problem of boar taint as the production of the male hormone androstenone is curtailed. Skatole concentrations in the fat are also reduced to below the critical concentration for taint, but the mechanism for this is not fully understood. However, boars grow faster than castrates and are more efficient at converting feed into lean meat, so castration increases production costs. Castration is also becoming an animal welfare issue, and shortly be banned in Norway, so it may not be an option indefinitely. Most European countries castrate all their male pigs except those retained for breeding, as this is seen as the only way to avoid negative consumer reaction to tainted pigmeat. Irish pig producers ceased castrating more than 20 years ago after research by the present authors (then under An Foras Taluntais) showed that at the low carcass weights in this country the risk of boar taint was negligible. However, average carcass weights have increased gradually over the last 20 years, so the risk of boar taint may well have also increased through its association with sexual maturity.

The main objectives of this project were to assess the current incidence of boar taint in the Irish pig population and to investigate strategies to reduce its incidence. Recommendations could then be made to the industry about the scale of the problem presently and in the future if carcass weights continue to increase and about how the incidence could be reduced.



## RESULTS

### *Incidence*

Fifty samples of belly fat were collected from boar carcasses at each of 7 export-licensed factories. These were assessed for boar taint by a trained panel of four women known to be sensitive to the taint. The panel members singled each sample with a soldering iron and recorded whether or not the characteristic taint was present. Samples were considered to have a definite taint if all four panel members recorded that it was present.

The incidence of samples with a definite taint was 8%. This incidence is similar to that found in another survey four years previously and is in line with incidences published for other countries. For a further 10% of samples three out of four judges scored them as tainted, suggesting a high probability of them also having the taint.

### *Effect of carcass weight*

There was a very weak relationship between carcass weight and the incidence of boar taint (Table 1). Therefore, the simple procedure of placing an upper weight limit for boars will not greatly reduce the incidence of tainted boars.

**Table 1:** Relationship between the incidence of boar taint and carcass weight.

No. judges finding taint	Weight group (kg)							Total
	55-60	60-65	65-70	70-75	75-80	80-85	>85	
0	23	17	23	26	21	22	15	147
1	12	15	12	16	11	18	21	95
2	7	7	7	5	5	4	3	38
3	5	4	5	3	8	5	4	34
4	2	5	1	2	4	4	8	26



### *Factory differences*

There were differences between factories in the average taint score (taint score for each sample equals the number of judges finding a taint), which could not be explained by differences in average slaughter weights (Table 2). Factories 1, 6 and 7 had higher than average taint scores. This variation probably reflects differences between producers in the incidence of taint. Such differences could be due to production factors or genetic differences.

### *Feeding and husbandry effects*

An experiment was carried out to test the effects of diet and management factors on the incidence of boar taint. Twenty-four groups of 14 crossbred pigs were assigned to one of four treatments. Pigs were penned in mixed sex groups or in boar-only groups and within each sex-type pigs were subjected to two diet/management regimes. The treatments were as follows:

- A. Boars alone, housed in fully slatted pens, fed a low protein diet (Diet no.1) containing the growth enhancer virginiamycin (not permitted in the EU for use in pig feed since 2000) by wet feed system.
- B. Boars alone, housed in part (25%) slatted pens, fed a high protein diet with amino acid content equal to A (Diet no. 2) in dry pelleted form.
- C. Mixed sex groups (50% boars, 50% gilts), housed in fully slatted pens, fed as A (Diet no. 1) by wet feed system.
- D. Mixed sex groups (50% boars, 50% gilts), housed in part (25%) slatted pens, fed as B (Diet No. 2) in dry pelleted form.

**Table 2:** Mean boar taint score for the 7 factories.

	Factory							Total
	1	2	3	4	5	6	7	
Taint score	1.72	0.63	0.68	0.85	0.81	1.75	1.33	1.11
No. pigs	50	49	50	47	48	47	49	340





Mean scores for each of the groups are shown in Table 3. Diet/management had a significant effect on the mean score, fully slatted pens and Diet no.1 reducing the overall score. Mixing boars and gilts might have been expected to increase the taint score due to increased stimulation of the boars, but mixing the sexes had no affect. The lowest mean score was recorded for boars reared with gilts on fully slatted pens fed the low protein diet by wet feeding (Diet no.1). Producers could reduce the risk of producing tainted boars by adopting these practices.

Table 4 shows growth and carcass data for the treatments. There was a significant effect of housing system/diet on growth rate and on feed conversion ratio with the fully slatted floor/Diet no 1/wet feed system being superior. These pigs were fewer days on trial but had a lower carcass weight. Carcass lean meat percentage was lower on the fully slatted floor/Diet no 1/wet feed system, probably due to the higher growth rates achieved on this treatment. The reduction in taint score of boars on fully slatted pens fed Diet no.1 was therefore not achieved with a sacrifice of production efficiency. Raising boars in single sex groups significantly improved feed conversion ratio but reduced carcass weight. Raising boars in single-sex groups did not affect the incidence of taint but may improve the efficiency of growth. Thus, producers could improve their overall efficiency by adopting single-sex rearing without increasing the risk of producing tainted boars.

*On-line indicators*

The scrotal sacks of boars from four breeds were collected on the slaughterline. The total weight of the sack, the weight of the testes, the weight of the epididymes and the length of the testes were recorded as indicators of

**Table 3:** Mean taint score for boars raised separately or mixed with gilts on two management/diet treatments.

Grouping	Housing/ Diet	
	Fully slatted/Diet no.1	Partially slatted/Diet no.2
Separate	1.04	1.21
Mixed	0.63	1.29



**Table 4:** Growth performance and carcass characteristics of pigs (36-92 kg liveweight) on different diets/management systems.

House/Diet	Fully-slatted/ Diet no.1		Partially-slatted/ Diet no.2		Significance <sup>1</sup>	
	Separate	Mixed	Separate	Mixed	Housing/ Diet	Grouping
Days on trial	71.0	71.7	78.2	79.1	**	NS
Carcass wt kg	69.4	69.1	70.7	70.0	**	**
Daily feed gm	1897	1853	1860	1891	NS	NS
Daily gain gm	797	749	738	729	**	NS
Feed/kg gain	2.38	2.48	2.52	2.61	**	*
Kill out %	74.8	74.7	75.0	75.3	NS	NS
Lean meat %	56.8	56.2	57.2	57.4	*	NS
Back fat mm	12.3	12.4	11.7	11.8	NS	NS

<sup>1</sup> NS = P>0.05, \* = P<0.05; \*\* = P<0.01

sexual maturity and therefore possible indicators of boar taint risk. There was no correlation between the size of the sexual organs and the taint score. Most of the considerable variation in the development of the sexual organs was due to breed differences (Table 5). The Duroc had the largest scrotal sack and individual organ weights and dimensions, followed by Large White, Hybrids and Landrace. The size of these sexual organs could not therefore be used as a simple on-line indicator of the likelihood of boar taint as breed is generally unknown on the line.

*Breed effects on boar taint score*

There were also breed differences in taint score, with the Duroc breed scoring highest, followed by Hybrids, Landrace and Large White, as shown in Table 6.



**Table 5:** Breed differences in sexual organ size (mean values and standard errors).

Breed	Scrotal weight	Testes weight	Epididymes weight	Testes length
Duroc	877.3 (65.6)	368.0 (38.6)	110.0 (9.2)	97.7 (4.3)
Hybrids	747.7 (24.3)	312.9 (14.4)	83.6 (3.4)	93.1 (1.6)
Landrace	714.7 (13.4)	284.2 (7.9)	78.4 (1.7)	88.4 (0.9)
Large White	758.7 (18.5)	342.4 (10.9)	88.7 (2.6)	94.6 (1.2)

**Table 6:** Breed differences in boar taint score after adjusting for carcass weight (scale 0-4, mean values and standard errors).

Breed	Mean taint score
Duroc	1.49 (0.44)
Hybrids	2.24 (0.19)
Landrace	2.03 (0.19)
Large White	1.37 (0.20)

The differences between breeds and the practical significance of this for the boar taint problem is shown more clearly in Table 7, which gives the frequencies of fat samples of each breed in each of the score taint categories. When all breeds were combined, the frequencies were not very different from those found in the factory survey (Table 1). An identical percentage (8%) of carcasses in the production trial to that found in the survey was judged by all four panel members to have a taint. A total of 21% of samples were judged by either 3 or all 4 panel members as having a taint, compared to 18% in the survey data. The sample size for the Duroc breed was too small to draw any firm conclusions, but there were some interesting differences between the



**Table 7:** Breed differences in the frequencies of carcasses in each category of boar taint score (number of carcasses and percentage).

Breed	Number		Taint Score			
		0	1	2	3	4
Duroc	16	4(25)	5(31)	6(38)	0(0)	1(6)
Hybrids	86	20(23)	22(26)	20(23)	12(14)	12(14)
Landrace	83	23(28)	14(17)	25(30)	15(18)	6(7)
Large White	76	28(37)	20(26)	19(25)	7(9)	2(3)
Total	261	75(29)	61(23)	70(27)	34(13)	21(8)

other three breeds. The Large White breed had by far the lowest incidence of samples with either all four (3%) or three of the judges (9%) finding a taint, while the Hybrids accounted for more than half of the 21 samples judged as tainted by all four panel members.

Breed is generally not known on the slaughterline, with the possible exception of the Duroc, due to its dark hair colour, so these breed differences are of no practical significance for sorting carcasses into taint risk categories. However, this knowledge could be useful in reducing the incidence of taint in the long term through changes in breeding.

### *Production indicators*

For the pigs in the above breed comparison trial a number of production factors were examined to determine whether any could be used as indicators of the risk of boar taint. Taint score was not significantly correlated with any of the production factors examined, including daily gain, food conversion efficiency, fat depths, lean meat index and terminal sire selection index. Insulin Growth Factor (IGF1) is sometimes used to select for potential growth rate. IGF1 data were also available for these pigs but, although there was a significant correlation between IGF1 and taint score, the correlation was too



low to be a useful indicator of boar taint ( $r = 0.1$ ,  $p = .05$ ). The only conclusion that can be drawn from these data is that selection for IGF1 would not be expected to markedly increase the incidence of taint in the population.

#### *Compounds responsible for boar taint*

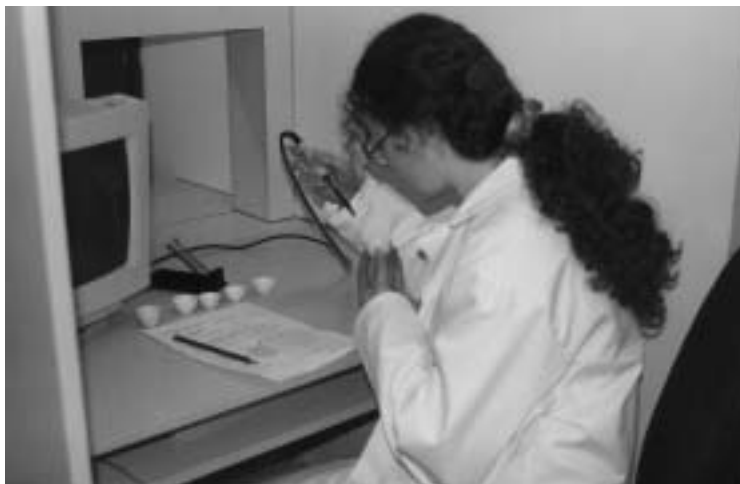
About 200 belly fat samples were analysed for androstenone and skatole concentration. The results indicated that androstenone rather than skatole is the compound of greatest concern in the Irish slaughter population. Over 90% of the samples were below the threshold for sensitive consumers for skatole, whereas 32% of the samples had androstenone concentrations above the threshold. There was also more variation in androstenone concentration with the maximum value being more than 7 times greater than the threshold value. Measures to reduce the incidence of boar taint in the Irish population should therefore be concentrated on controlling factors that affect androstenone production. There was a moderately high correlation between androstenone and skatole content, as has been reported by others. Measures to reduce androstenone would therefore be expected to also reduce skatole and consequently have a considerable effect on the incidence of boar taint. The concentrations of both compounds were significantly correlated with the sizes of the sexual organs. However, these correlations were not sufficiently high to be of practical use in screening for boars with a high concentration of compounds responsible for boar taint.

#### *Development of an objective method of determining boar taint*

The sniff panel score was not correlated with the concentration of either compound in carcass fat samples, nor was it correlated with the sizes of the sexual organs, whereas androstenone and skatole content were correlated with sexual organ size. This brings into question the effectiveness of the sniff panel, but it also raises the possibility of compounds other than androstenone and skatole being responsible for boar taint, as has been suggested by others. The justification for the final task of the project, developing an objective method of identifying taint using an electronic nose, was to overcome the problems associated with the subjective nature of sniff panels in addition to the cost and practical problems associated with running panels.



▶  
*A trained panellist checks for boar taint using a soldering iron to heat fat samples.*



An electronic nose (Alpha Moss Fox 3000) uses an array of sensors to create a 'fingerprint' of the volatiles in the headspace above a sample. If the system is calibrated for known compounds it is then possible to group unknown samples according to the concentration of these compounds in the sample. Because the sensor responses are dependent on many factors it is necessary to develop a precise method of sample preparation that gives repeatable results and sufficient discrimination between groups. Two groups of belly fat samples with either high concentrations or undetectable concentrations of both androstenone and skatole were used to give maximum discrimination but it was not possible to find a method that gave both discrimination and repeatability. The problem probably relates to the complex nature of the belly fat and the large number of other volatile compounds in the headspace. Other workers have shown that the electronic nose can discriminate for androstenone, but in spiked samples of purified fat rather than actual subcutaneous fat. With developments in sensor technology it is possible that a method could be developed in the future, but in the meantime the sniff panel is the only alternative to expensive analytical methods for the two compounds.



## CONCLUSIONS

- The incidence of boars with a taint that is detectable by trained sensitive consumers was 8%.
- There is no indication that the incidence is increasing since this is the same incidence as was found in a previous study.
- There was a weak relationship between the incidence of boar taint and carcass weight.
- Restricting the carcass weight of boars is therefore unlikely to significantly reduce the incidence of boar taint.
- Two factories had significantly higher incidences of tainted boars, probably related to producer differences.
- These producer differences could be due to production factors or genetic effects or both.
- Housing and diet affected the incidence of boar taint but mixing boars and gilts did not.
- The lowest incidence of boar taint was found when boars were mixed with gilts on fully-slatted floors and fed a reduced protein diet containing virginiamycin (not permitted in the EU for use in pig feed since 2000), using a wet feeding system.
- This production system was also the most efficient in terms of growth rate and feed conversion efficiency.
- The sizes of the sexual organs were not related to the incidence of boar taint so they cannot be used as on-line indicators of the problem.
- The Large White breed had the lowest incidence of boar taint and the Hybrids had the highest.
- Production factors such as daily gain, food conversion efficiency, fat depths, lean meat index and terminal sire index were not correlated with the taint score..



- Androstenone was more important than skatole in determining the presence of boar taint, with 32% of boar carcasses over the sensitivity threshold for androstenone compared to only 10% for skatole.
- An attempt to develop an objective method of identifying boar taint, using an electronic nose, was not successful

## RECOMMENDATIONS TO INDUSTRY

While the incidence of boar taint in Irish pigs is at the lower end of the range reported internationally and there is no evidence that the incidence is increasing, it still represents a potential problem to an exporting industry. Pig producers harness considerable savings in production costs by not castrating and processors improve the efficiency of the processing operation by increasing average carcass weights annually. To safeguard these cost reductions, measures should be taken by the industry as a whole to reduce the risk of tainted carcasses getting onto the market. Producers should adopt as far as possible the production practices that have been shown to reduce the incidence of boar taint. These include mixing boars with gilts on fully-slatted floors and feeding a reduced protein diet, using a wet feeding system. The use of the Large White breed should be encouraged and that of the Hybrids discouraged to reduce the incidence of boar taint. Consideration should be given by the breeding companies to screening boars for taint, particularly among the Hybrids, Landrace and Duroc breeds. Also, the causes of the differences between factories in the incidence of boar taint should be investigated as this may give important further information about production factors and breed differences.





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## PUBLICATION FROM THIS PROJECT

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# The National Food Centre

RESEARCH & TRAINING FOR THE FOOD INDUSTRY

Dunsinea, Castleknock, Dublin 15, Ireland.

Telephone: (+353 1) 805 9500

Fax: (+353 1) 805 9550



**EUROPEAN UNION**  
European Regional  
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