



# Removing the taint

Bottlenecks and possible directions for a  
solution in the marketing of the meat of  
non-castrated male pigs



WAGENINGENUR

*For quality of life*

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# Preface

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Wageningen UR has published a summary note on the subject of the castration of boars. There is a need in practice for a summary in simple language of the present knowledge about castration and the possible directions for a solution.

Many results were obtained from an investigation that was started in the summer of 2006 into the bottlenecks in the marketing of the meat of non-castrated male pigs, commissioned by the Ministry of Agriculture and jointly financed by business. The project is a logical follow-up to the report of the 'Werkgroep Alternatieven voor het Castreren van varkens' [Alternatives to the Castration of Pigs working group] of 2005. A number of bottlenecks to which that report drew attention are further analysed here.<sup>1</sup>

This note summarises the knowledge gained up to the present. Further information can be found in the reports of various subsidiary studies, to which reference is made in the various footnotes in the text.

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General Director LEI  
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# Introduction

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**S**'Since boars' meat is less tasty, the young boars which are intended for fattening are always castrated', states Veenman's *Agrarische Winkler Prins [Encyclopaedia]* of 1954, emphatically and self-evidently.

The castration of boars was even so self-evident in the last century that we know relatively little about the unpalatable taste that was thus avoided, referred to as boar taint. Since then the non-anaesthetised castration of young boars (male pigs) is no longer found so socially acceptable, but is regarded as an infringement of the wellbeing and the integrity of the animal. Partly for that reason, pig farmers find it an unpleasant task. There are also economic disadvantages: castrated boars require relatively more feed and have a less favourable meat to fat ratio.

The great obstacle, however, is that the meat of non-castrated boars is anything but popular in the international trade. Because of the fear of boar taint, considerably less is paid for boars' meat and important market parties - in the Netherlands and beyond - will accept no boars' meat at all. In other words, boars' meat is not accepted by the market. And because male pigs make up half of the number of pigs, stopping castration leads to serious economic losses.

## What is boar taint?

Boar taint is a penetrating unpleasant odour (and accompanying taste) in pork. Where it is very strong, it is associated with manure,

urine and sweat. One incidentally only really becomes aware of this odour (and taste) when the meat is heated, i.e. in the pan.

There is no problem with cold meat products. The majority (and most valuable) of the parts of the pig, however, are destined precisely for the fresh meat market, or for 'the pan'. Three compounds are generally regarded as responsible for this boar taint: androstenone, skatole and, to a lesser extent, indole.

Androstenone is a testicular steroid with a strong urine odour. This substance is important for the formation of semen and the sexual behaviour of the boar. In the majority of European pig races, this semen creation begins in about the 18th week on average at a weight of approximately 60 kilos. From that point, the concentration of androstenone in the fat usually increases. Skatole is a non-sex-specific substance which arises from the breakdown of certain amino-acids in the body. For as yet unexplained reasons, the concentration of this substance in the fat of male pigs is three times as great as in that of female pigs.

However, castration reduces the concentration by a factor of one-and-a-half to two. Skatole can also be absorbed through the skin. This means that animals that lie in their own dung will have more skatole. Indole, which is related to skatole, also plays a role. These three substances incidentally explain only two thirds of the variation in boar taint. Most probably, still more substances (in a reciprocal relationship or

otherwise) play a role. What is clear is only that a **marked** boar taint is associated with **high** concentrations of androstenone and skatole, in particular.

The above makes clear that boar taint is a gradual phenomenon. It is dependent on the concentration and combination of certain substances in the fat. With castrated and female pigs, the likelihood of boar taint is very low. With older (i.e. heavier) non-castrated male pigs this likelihood is considerably higher.

## Acceptance

At the same time, boar taint is literally a question of taste. The problem concerns not purely the concentration of certain substances, but also how the consumer experiences the odour and flavour associated with these substances. For example, a considerable proportion of consumers (30%, rather more men than women) were found to be not at all sensitive to androstenone, in particular. Moreover, consumers in one country appear to have considerably fewer problems with what we call boar taint than consumers in another country. That could be related to habituation, but also to the manner in which pork is prepared. People who use a lot of herbs, for example, will be less aware of the taint.<sup>2</sup> It should incidentally be remarked there is very little experience of non-acceptance by consumers because the pork chain almost nowhere brings fresh meat from non-castrated adult boars onto the market. The abattoir, meat packer, butcher and supermarket simply will not run

the risk. It is therefore not known what percentage of adult boars actually have boar taint. Estimates vary widely.<sup>3</sup>

## Consumer research<sup>4</sup>

In the context of 'Removing the taint' an investigation was held among 121 Dutch consumers to discover the extent to which they accepted boar taint.

For this purpose, samples were first taken of the bacon from 677 boars of a pure pig breed line. Eight of the samples had relatively high percentages of androstenone (>2.0 mg/kg), skatole (>0.3 mg/kg) and indole (>0.2mg/kg). In addition, there were 23 samples with somewhat enhanced percentages of androstenone, skatole and indole. In comparison with other investigations, few samples were found with enhanced or high contents, i.e. fewer than 5%. The samples, the contents of which had thus been established in the laboratory, were then submitted to an experienced expert panel of seven people for assessment, at which stage the conclusion from earlier research was confirmed: at low concentrations, the assessment (even by an expert panel) can vary widely from 'no boar taint' to 'distinct boar taint'. At high concentrations, most of the experts noted 'distinct boar taint'.

Three kinds of samples were then selected for an investigation among 121 pork consumers: samples which, according to the experts, did or did not have boar taint, and a group of samples which had been labelled by the experts as 'doubtful'. The lat-



ter group was also further subdivided into samples with low or enhanced contents of the substances concerned.

Each person was given 6 pieces of bacon (with both categories of 'doubtful' being offered twice) and had to award a score of from 1 to 10 for acceptability, unpleasantness and taste. It was striking that only a weak relationship was noted with the assessment of the expert panel. Although there was an observable (but not dramatically) lower appreciation for bacon 'with boar taint', the differences were otherwise not significant.

The overall conclusion was that there was no clear preference among these Dutch consumers for samples with low androstenone, skatole and indole contents. Swiss research running in parallel (as yet unpublished) appears to reach the same conclusion.



# Preventing boar taint

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## Castration without anaesthetic

In order to prevent boar taint, young male pigs in the majority of EU countries are surgically castrated. This affects some hundred million animals annually. Pig farmers are allowed to do that without anaesthetic to pigs up to the age of 7 days, which is also what happens in practice. With older piglets, castration is permitted only under anaesthetic, supplemented by long-acting pain control and this must be carried out by a veterinary surgeon. In castrated pigs, no androstenone is formed and, for still unexplained reasons, less skatole is also formed. It should be added in passing that castrated boars (hogs) are less aggressive than boars. For the pig farmer and the welfare of animals housed in groups, that is an advantage.

## Castration under anaesthetic

A study has also been carried out into castration under anaesthetic.<sup>5</sup> This showed that castration demonstrably causes less pain and stress if lidocaine is used beforehand as a local anaesthetic. Nevertheless, the wellbeing-enhancing effect appears to be relatively limited; there is still pain and stress and there is, moreover, the pain from the anaesthetic injection itself (in the testicles), which has not been investigated. The intramuscular administration of meloxicam (long-acting painkiller; a kind of aspirin) before castration has a limited effect at the moment of castration. Behaviour observation during the first 4 days after castration showed that castration under local anaes-

thetic caused more pain-related behaviour than castration without anaesthetic. This difference in after-pain does not appear if meloxicam is given. Meloxicam proved in both cases to be effective against after-pain. If the local anaesthetic is given by the veterinary surgeon, the costs of castration increase by €1.00 per male piglet. If the pig farmer is allowed to do it himself, the cost is €0.28 per male piglet. At the national level, we are talking about 13 and 3 million euros per annum respectively. With general anaesthetisation with CO<sub>2</sub>, there is loss of consciousness and complete painkilling during the castration. A further advantage is that any other painful treatments can take place at the same time. By combining anaesthetisation with CO<sub>2</sub> with dosing with Meloxicam, the after-pain is also controlled. The only disadvantage is that the safety margins (in CO<sub>2</sub> concentration and in time) are very narrow. That is one of the reasons why no reliable and practical method of administration is yet available. Research has now been started to allow this method to be applied in practice in mid-2008.

## Slaughtering young

As we have said, the likelihood of boar taint increases as the boars approach sexual maturity. One could therefore slaughter the pigs at a younger age (and thus at a lower weight). This also explains why in such countries as Great Britain, Ireland, and usually in Spain and Portugal, male pigs are not castrated; they are slaughtered at a lower weight (up to a slaughter weight of 85 kg).

A calculation has been made in the context of 'Removing the taint' of the economic effect if the Netherlands were to adopt (immediately and unilaterally) the practice of slaughtering non-castrated boars at a younger age.<sup>6</sup> This should happen at a weight of 75 to 85 kg (average of 81). The overall result of this calculation is that the value added in the pig chain (from fattening to the selling of cuts) would fall by some 90 million euros or 10%. That is considerably more than the present margins.

The decline manifests itself principally at the level of meat sales. Because today's foreign customers do not want boars, the Dutch abattoirs will have to absorb them themselves and consequently three-quarters of the pigs on the hooks will be boars. Because these are lighter, they will yield 8% less meat, which means a loss of turnover of approximately 210 million euros. Moreover, certain cuts from lighter pigs also yield a lower return (a heavy ham yields more per kilo than a light one), and the market will probably also pay less for the meat of

**young** boars. These items are calculated at a further approximately 50 million loss of turnover.

The primary producers will continue to produce about the same quantity of meat per pig place. Although the boars supplied are not only lighter but also **younger**, they make way more quickly for the next batch. As we have said, the Dutch abattoirs will be taking less 'weight' (relatively much lighter boars). And thus more live weight (heavier gilts) will go abroad - an increase in turnover of about 160 million euros. An advantage is that boars need less feed than hogs, because their food conversion is considerably lower. This will make a difference of some 80 million euros in feed, while proportionately fewer minerals will be also lost through the manure: a cost saving of some 10 million euros.

Lastly, more piglets will have to be bought (50 million) and €30 million will have to be incurred in extra costs (more animals, more and separated transport, etc.).



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## Breeding

The content of androstenone and skatole has been found to be inheritable. This means that they can be bred for and the possibility has also been examined in the context of 'removing the taint'.<sup>7</sup> Breeding for particular characteristics traditionally takes many years. 'Genomic selection' also offers that prospect, all the more so because a great deal is already known about the genome of the pig. If it is clear precisely which genes are responsible for boar taint, it will be possible to develop a 'genetic test' for determining whether an animal has the desired genes.

This would obviously be easiest if it concerned only one or a few 'demonstrable' genes (the 'single gene case'). A complication arises when a gene that is 'undesirable' from the perspective of boar taint is also responsible for other characteristics that are desirable. With androstenone one thinks, for example, of fertility. The complexity - including that arising from a group of related characteristics - becomes even greater if boar taint is found to be caused by the interaction of several genes. In that case a 'genetic test' will be virtually impracticable and one will have to test the descendants to check whether they have boar taint or not. A further delay arises from the fact that boar taint manifests itself only after the passage of time.

A quick scan of the literature (Brascamp et al., 2007) shows in the first place that selection for high levels of androstenone and skatole is possible and, therefore, also for strong boar taint. Whether that also applies to 'absence of boar taint' is still uncertain.

Analysis of databases, which are still largely to be collected, of androstenone and skatole contents can give an insight into the question of whether this is a 'single-gene case' or not. If it is, success could be achieved within 5 to 10 years with today's technology. Otherwise, it may take longer.

It would further help the speed of selection if one could already measure boar taint in live animals. At present, it can only be measured in the bacon of slaughtered boars. In particular, if it proves not to be a single gene case, the breeding programme will have to contend with the danger of the indirect effects of selection, for example, in relation to fertility, mating efficiency, early maturity of gilts, etc. And - as with most solutions - the decisive question is whether a satisfactory 'boar taint-free' product will ultimately be accepted by the trade and retailers. This aspect merits extra emphasis here, because it indicates that breeding organisations which start such a programme run a considerable investment risk.

## Immunoneutralisation<sup>8</sup>

There is a vaccine in existence that (indirectly) strongly inhibits testicle growth and thus the production of androstenone. This method has long been used in Australia, for example, and has proved to be reliable.

Two injections at the age of 10 and 18 weeks are sufficient. Should things go wrong, that is readily observable on the slaughter line from the appearance of developed testicles.

The principal problem with this method is

that the vaccine also works with humans. That causes in the first place a safety problem during the injection: a person who accidentally injects himself for the second time can himself become temporarily infertile.

Another question is how consumers will react. The vaccine is completely harmless to the consumer because it works only through direct injection into the bloodstream (i.e. not given through the mouth). Moreover, it has already almost completely disappeared from the pig before slaughter. The association with hormones and drugs and fear for one's own infertility can nevertheless give rise to consumer reactions. The vaccine has not yet been permitted in Europe. According to Swiss research, well-informed consumers would accept meat from pigs treated with such a vaccine. A final question which has not yet been clearly answered concerns whether boar taint is completely absent from treated pigs. The literature suggests that immunocastration can give no guarantee of this.

## Management measures

A generous water supply, good sty hygiene and adjusted feed can contribute to a lower skatole content, but this does not give a 100% guarantee. Moreover, skatole is only one of the substances implicated.

## Sexing of semen

It is theoretically possible to select only female semen before fertilisation. Work has already been proceeding on this for some time in cattle farming, but the experiences there do not lead one to suppose that such a method will be feasible for pigs in the short term, the more so because pig semen can be kept for only a very short time and vast quantities of spermatozoons are required for each insemination. Should it already prove possible to separate the spermatozoa in a satisfactory manner, the speed and the related costs of doing so will constitute a further bottleneck.

## Detection on the slaughter line

Boar taint in the consumer product could also be avoided by removing all the boars with boar taint in the abattoir. This would enable a 'boar taint-free' guarantee to be given for the remaining meat. This 'end-of-pipe' solution is not very attractive if boar taint occurs frequently in practice. If - in line with the most pessimistic estimates - 75% of the boars do indeed have boar taint, one would have to find another (less lucrative) use for the same percentage. If little boar taint occurs (because it has already been greatly reduced through other measures), such a safety net on the slaughter line would appear to be an attractive final check.

Apart from the technical possibilities, the problem here resides mainly in the standards which are imposed. And then

it is mainly the 'doubtful' group which is concerned, as also appeared from the consumer research. Although one can measure the androstenone, skatole and indole content fairly exactly, these contents do not appear to show a clear linear relationship with the boar taint perceived by the consumer. In order to give a 'guarantee', one would have to aim at very low contents, but then the percentage of rejects on the slaughter line might prove to be very high. All this with the knowledge that a considerable proportion of this will have no boar taint whatever.

The possibilities of detection on the slaughter line have been explored in the context of 'Removing the taint'.<sup>9</sup> The starting point was that the method has to be sufficiently certain and exact, and it must also be fast. The method must keep pace with the speed at the slaughter line and preferably be able to deliver an analysis within half an hour, i.e. before the carcasses disappear into the cold stores. And, in the third place, it must be affordable.

On the evidence of research in Norway, rapid gas chromatography, combined with fat extraction, seems promising. Using this method, the three substances can be measured in a single analysis, although there are still a number of technical and organisational obstacles to be overcome. More fundamental, however, is the question of whether the content of these substances is a sufficient measure for answering the question of whether boar taint is present.

### **Views of stakeholders about alternatives**

There are widely differing views within European countries (EU member states, Norway and Switzerland) on alternatives for the castration of male piglets. All the parties concerned in the European regions have a slight preference for castration under anaesthetic and the sexing of semen.

The relative scores of the parties in the pig farming industry chain show the following picture. The present practice of surgical castration is preferred by pig farmers, abattoirs and the meat-processing industry. Consumers, NGOs and policy makers have a strong aversion to this practice. Apart from NGOs, castration under anaesthetic is preferred by all the other chain parties. The fattening of boars is strongly preferred by NGOs and policy makers. This alternative has a low score among pig farmers, abattoirs and consumers. Immunocastration is not preferred by producers and consumers. Only policy makers have a certain preference for this alternative. Semen sexing is preferred by all the parties except the abattoirs and the meat-processing industry.

# Interim evaluation

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## Definition and market acceptance

The boar taint question is primarily a problem of market acceptance. In order to avoid any negative consumer reaction, the international trade does not want any boars' meat. Boars' meat is labelled as 'low quality' and is therefore not accepted or realises a markedly lower price. That would cause a big problem if the Netherlands - as an exporting country - were to abolish the castration of boars unilaterally. In that sense, it would be in the interest of the Netherlands (and the pigs) if the castration discussion were to be carried on in a European context.

However this may be, buyers of pork - both the trade and the final consumer - want to run as little as possible risk of getting smelly pork. In answering the question of how one could give guarantees against it, one is faced by the problem that there is no broad definition of boar taint accepted by the market. We actually do not really know what it is. It is significant that - even in the scientific literature - the estimate of the percentage of boars with boar taint varies widely.<sup>3</sup> Studies have shown further that the 'experience' of boar taint varies by country, by sex and by individual. This makes it difficult to get a grip on how consumers experience the odour and taste of boars' meat.

We are accustomed to assume a relationship between the experience of boar taint and the presence of androstenone, skatole and indole in the boar bacon. In reality, the



concentration of these substances has been found to explain only two-thirds of the consumer experience. This applies equally to the judgement by expert panels. Research results show that it is unlikely that there is a simple solution to stopping castration. A search has to be made for a combination of different methods.

Viewed in this light, it seems we must take care not to fall into the same trap as the Danish meat companies who, some years ago, installed an expensive detection method on the slaughter line, directed at skatole (in which incidentally 20% of the animals were rejected) and which method - that had cost many tens of millions of euros - was subsequently rejected by the German veterinary department. The case is still being heard by the European Court. This is a proof that it is important that we should have a good idea

of precisely which problem we now wish to solve.

It is therefore recommended that directed research be carried out into the essence of boar taint, a complex combination of aromatic substances, in order to discover whether it is possible to give better guarantees for individual submarkets.

Directions for solutions must be investigated in relation to the industry and the chain together with stakeholders.




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## Literature

- <sup>1</sup> *Meer beren op de weg*, Final report of the *Werkgroep alternatieven voor het castratie van varkens* [Alternatives to the Castration of Pigs working group], January 2005. This working group was an initiative of LTO Nederland and Dierenbescherming [Animal Protection].
- <sup>2</sup> *Welfare aspects of the castration of piglets*. ESFA Journal (2004) 91, p. 45 et seq.
- <sup>3</sup> In *Welfare aspects of the castration of piglets*, ESFA Journal 2004 (91), p. 45 refers to 10 to 75%. John-Erik Haugen of the Noorse Matforsk (LEI Wageningen UR, 5 July 2007) mentions 20 to 80%. Our own consumer research (see note 4) did not find more than 1.5%.
- <sup>4</sup> CCL and Essensor. *Sensorische beoordeling van spekmonsters op berengeur*. Report 1001325. CCL & Essensor, October 2007
- <sup>5</sup> Kluivers-Poodt, M., H. Hopster, H.A.M. Spoolder, *Castration under anaesthesia and/or analgesia in commercial pig production*. ASG Wageningen UR. Report 85, December 2007.
- <sup>6</sup> Baltussen, W.H.M., G.B.C. Backus, W.H.G.J. Hennen (2008) *Economische effecten van het per direct stoppen met castratie van beerbiggen in Nederland*, Report 5.08.02, LEI, The Hague.
- <sup>7</sup> Brascamp, E.W., A.L.Archibald, J. ten Napel *Perspectives of genetics and breeding to prevent boar taint*.
- <sup>8</sup> See also: [/www.pigprogress.net/management/id1138/welfare.html](http://www.pigprogress.net/management/id1138/welfare.html)
- <sup>9</sup> John-Erik Haugen, Matforsk, Norway.



The background of the page is a detailed anatomical dissection of a ribcage, showing the ribs, intercostal muscles, and internal organs. The entire image is overlaid with a semi-transparent orange filter. A horizontal white band is positioned across the upper third of the page, containing the university's description.

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