Experience with use of local anaesthesia in piglet castration

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Background - The Norwegian situation
In 2002, the Norwegian parliament decided to ban castration in Norway from January 1st 2009. From August 2002 and until the implementation of the ban, castration is only allowed by veterinarians, and anaesthesia is mandatory. If the piglets are older than 7 days, additional long term pain relief should be used. No further specification is given about type and administration of anaesthesia, procedures for surgery etc.

Local anaesthesia - Two Norwegian studies
The effect of local anaesthesia in piglet castration was investigated in the study “Castration of piglets: analgesic effects of intratesticular and intrafunicular lidocaine injection” (Haga & Ranheim 2005). Both intratesticular and intrafunicular administration was shown to have good analgetic effect, evaluated by surveillance of arterial blood pressure and pulse rate, when combined with subcutaneous administration on the site of incision.
In the other study “Distribution of radiolabelled (14C) lidocaine injected into the testes in piglets”, the diffusion of lidocaine to the spermatic cord was shown to be satisfactory three minutes after intratesticular administration.

A Norwegian survey - experience of practice
To evaluate the new policy with veterinarians performing all piglet castration with use of local anaesthesia, veterinarians and pig producers were asked to fill out a questionnaire regarding their experiences with the new castration practices (Fredriksen and Nafstad 2006). The answers showed that the piglets were most often castrated using a combination of subcutaneous and intratesticular administration of lidocaine with adrenaline at an average age of 10 days. The effect of the anaesthesia was regarded as good by 54% of the veterinarians and 19% of the producers. Post-operative complications were rare. The overall evaluation showed that two-thirds of the veterinarians, but only one-third of the pig producers were satisfied or very satisfied with the implemented policy. However, while two-thirds of the pig producer had a negative attitude to the policy before it was implemented; only one-third were dissatisfied after two years experience.

The Norwegian strategy
To cope with the challenges of abandoning castration from 2009, a research programme was launched in 2004. The programme consists of five different projects within the subjects genetics, physiology, feeding/managing, detection and consumer perception/product development. The programme is financed by the Research Council of Norway, a fund built on the purchase tax and research funds from the Ministry of Agriculture. There has been an evaluation of the programme during the autumn 2006. The conclusion is that valuable research has been performed, but there is no chance of implementing the ban in 2009 without large negative consequences for Norwegian pig production. A reference group recommends therefore a postponing of the implementation of the ban.
International co-operation, both within research and in policy making, is important and necessary to abandon castration without negative consequences for consumers, producers and for the industry.

References

Genetic selection to prevent boar taint

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Background
Boar taint occurs in entire male pigs primarily due to excessive accumulation of two compounds, skatole (3-methyl indole) and androstenone (5α-androst-16-en-3-one) in adipose tissue (Lundstrom and Bonneau, 1996). It is well established, that the levels of skatole and androstenone vary between breeds and between individual animals within a breed, which implies a genetic control of boar taint. Extensive research has been carried out to identify genes controlling boar taint. The main approaches used are: (i) Quantitative Trait Loci (QTL) identification; (ii) physiological candidate gene identification.

QTL studies
The following QTL’s for boar taint have been identified so far:
- QTL’s for skatole on chromosomes 6 and 14 (Lee et al., 2004; Varona et al., 2005).
- QTL’s for androstenone on chromosomes 3, 4, 7 and 14 (Quintanilla et al., 2003; Lee et al., 2004).

Physiological candidate gene studies
The physiological candidate gene approach aims (i) to determine genes controlling the skatole and androstenone accumulation and (ii) to identify polymorphism(s) in these genes and to establish whether these polymorphisms are associated with skatole/androstenone levels.

Control of skatole deposition. Skatole is produced by bacterial fermentation in the gut, and transported via the blood stream into liver where it can be metabolised. The main enzymes involved in the hepatic skatole metabolism are CYP2E1, CYP2A6 and conjugative enzymes (in particular SULT1A1).

A functional polymorphism has been identified in CYP2E1 coding region (substitution of G to A at the base 1423) (Skinner et al., 2005; Lin et al., 2006). However no association between this polymorphism and skatole level was found (Skinner et al., 2005).

Functional mutations have also been identified in CYP2A6 (deletion at the base 421) and SULT1A1 (substitution of A to G at the base 546) (Lin et al. 2004a; Lin et al. 2004b). There are no evidences for an association between these mutations and a high skatole level (Skinner et al., 2006).

Extensive studies have been carried out on the mechanisms regulating CYP2E1 expression. COUP-TF1 and HNF-1 have been identified as essential for the regulation of expression of the pig CYP2E1 (Tambyrajah et al. 2004). No polymorphims related to skatole accumulation have been reported for these transcription factors yet.

Control of androstenone deposition. Androstenone is produced in testis and is metabolised in pig liver. The key enzymes involved in the biosynthesis of the 16-
androstene steroids in testis are CYB5 and CYP17. The main enzymes involved in the hepatic androstenone catabolism are 3β-HSD and conjugative enzymes (in particular SULT2A1).

A single nucleotide polymorphism (SNP), which decreases the enzyme expression, has been identified in 5'-untranslated region of CYB5 (Lin et al., 2005). Association between this SNP and androstenone level is not clear.

A number of polymorphisms have been identified in the pig hepatic 3β-HSD (Cue et al., 2006) and SULT2A1 (Sinclair et al., 2006). No association between the polymorphisms and androstenone level were found.

**Conclusions:**
(i) A number of QTLs for skatole and androstenone deposition has been reported.
(ii) A number of physiological candidate genes for boar taint have been identified.
(iii) A number of functional polymorphisms in the genes controlling skatole and androstenone deposition have been reported.

**Further work:**
(i) Further study on the mechanisms regulating skatole/androstenone deposition.
(ii) Identification of other candidate genes for boar taint and functional polymorphisms in these genes.
(iii) Investigation of the association between the polymorphisms found and skatole/androstenone level.
(iv) Developing genetic markers for boar taint.

**References:**
Genetic selection to prevent boar taint

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In order to find new ways of preventing castration in pigs, a pilot experiment has been performed on the identification of boartaint (androstenone) markers with the help of proteomics. In a collaborative study with Norsvin breeding company and the Norwegian School of Veterinary Science, 48 boars of Duroc breed were selected for androstenone levels in backfat, ranging from 0.30 to 9.95 µg.g-1. Samples from testis tissue were homogenised, centrifugated in order to produce a microsomal fraction, and purified for a better resolution when separated on polyacrylamide gels. Purified proteomes of 4 animals with extremely high androstenone values were combined, and density of individual proteins was compared after 2D electrophoresis with the same proteins of 4 combined animals with extremely low androstenone values. A total of 11 statistically different protein spots was found by PDQuest image analysis, and after excision and MS-MS-Maldi-TOF 4 candidate marker proteins could be identified.
Immunological castration as alternative to surgical castration of male piglets

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Castration in male pigs is usually performed during the first weeks of life without prior anesthesia. This technique, however, is known to induce acute pain and stress and will therefore not be tolerated any longer by animal welfare organizations. Practical and animal-friendly alternatives to surgical castration are the production of entire male pigs, semen sexing or immunological castration. Fattening boars has the benefits of better feed efficiency, higher lean meat yield and increased animal welfare due to no pain and stress of castration. The most important disadvantage in raising entire male pigs is the incidence of boar taint ranging between 10 and 75%. To identify tainted carcasses an accurate and rapid on-line method for detection of odorous compounds is absolutely necessary. Sperm sexing through flow cytometry is the only commercially available method at the moment but speed of separation is too low for practical application. Active immunization of boars against gonadotropin-releasing-hormone (GnRH) at the end of the fattening period results in a significant reduction of testicular weight and androstenone production while the benefits of daily growth gain, meat quality as well as welfare remain the same as in entire males. In the present review more detailed information is given about the various techniques, especially the practical application of immunocastration on a large scale base.

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Detection of boar taint at the slaughter line

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Boar taint is an odor and taste associated with meat of intact male pigs and related to their maturation and sexual development (weight and age). The background of boar taint is a complex of different hormones (among others androstenon) and other biological substances (among others skatol and indol).

In case boars are not castrated, a substantial number of their carcasses will, on a lower or higher incidence be affected by a varying degree of boar taint, which is an odor and taste that is unacceptable for different pork markets and moreover the consumers. In the case that in the near future management (breeding, feeding and housing) or immunological castration will be applied to decrease boar taint and in that way reduce the need for castration, the market and consumers expect a guarantee with regard to the absence of boar taint in the pork. Detection of boar taint is up till now done by a boiling or soldering iron test in the slaughter house, which is not feasible for a large scale application.

E-nose technology, based on modern absorption and detection principles, widely applied for other food quality control aspects, has the potential perspective for detection of boar taint in the slaughter line (high accuracy and speed at low cost). At laboratory scale this technique is already in use, for the application in a commercial slaughter line an innovative and integrative approach of research and industry is needed to enable successful detection of boar taint.

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Economic aspects of producing boar meat

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Introduction
European consumers have growing interest in food safety and quality. Concerns range from the health risks of consuming food to the environmental and animal welfare implications of production processes. The traditional way of castrating boars is one of the issues that are questioned. The literature shows that no simple alternatives available.

The aim of this presentation is to highlight the main economic aspects associated with three possible alternative strategies for the present traditional way of castrating boars. A basic assumption is that an EU policy regarding a future ban on the castration of male pigs will apply for all EU member states. The three strategies are: (1) Fattening entire males combined with control measures to ensure that consumers keep satisfied about pig meat and pig meat products; (2) immunocastration; and (3) surgical castration with anesthesia. The economic aspects are viewed from the perspective of the whole European pork supply chain, including citizens, consumers, retail, processors, farmers, and pig genetics. It is important to recognize that an important limitation stems from the limited availability of field data. Work is underway to expand the analysis in a more sufficient manner.

Fattening entire boars
Fattening entire boars requires control measures to reduce the quantity of boar tainted meat. Examples are reduction of carcass weight, husbandry or genetics. Measures to detect tainted meat are also necessary. A combination of measures is required to achieve an efficient and effective way of fattening entire boars. Which precise combination of measures is the most effective and efficient is not known yet.

The main advantages of fattening entire boars are an increase in: (a) animal welfare; (b) labor conditions for pig producers; (c) meat quality; and (d) lower on-farm production costs per kg of meat. The value of better on-farm productivity for the EU market approximately equals about 1 billion euros annually.

The main disadvantages of fattening entire boars are: (a) additional control costs; (b) risk of lower market prices for pork meat products; (c) the absence of practical experiences how to optimize this strategy; (d) substantial changes in the pork supply chain are required; and (e) present methods of detection are not accepted by the market. Total costs for this strategy can not be calculated yet, but will depend on the measures taken and – among other factors - on the average slaughter weight in a country. Total costs can outweigh the potential benefits.

Immunocastration
For the immunocastration strategy the boars are vaccinated twice at the end of the fattening period. It is assumed that the meat quality will be similar to the meat quality of boars.

The main advantages of immunocastration are: (a) It is practiced already in Australia and New Zealand; (b) it requires little changes in the pork supply chain. Main changes are required at the farm level; (c) there is no increased risk of meat
with boar taint; (d) additional on-farm productivity benefits are estimated at about 750 million Euros annually for the whole EU market.

The main disadvantages of immunocastration are: (a) less improvement of animal welfare (two vaccinations); (b) risk of negative associations of citizens and less favourable consumer perception; (c) handling risks for the person who vaccinates and (d) with imperfect markets, potential economic chain surplus will be distributed towards pharmaceutical industry.

**Surgical castration with anesthesia**

The main advantages compared to the traditional way of castration are: (a) no changes in pork chain are required; and (b) no increased risk of boar taint in carcasses.

The main disadvantages are: (a) boars are still castrated; (b) the positive impact on animal welfare is questionable; (c) slight increase of costs on farm level because of the use of anesthesia; and (d) additional labor for castration is required.

**Summary of the three strategies**

In table 1 the three alternative strategies are compared with each other on different aspects.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Fattening entire boars</th>
<th>Immunocastration</th>
<th>Surgical castration with anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welfare of pigs</td>
<td>+++</td>
<td>++</td>
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<tr>
<td>Welfare of farmer</td>
<td>++</td>
<td>++/-</td>
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<tr>
<td>Effects on environment</td>
<td>++</td>
<td>++</td>
<td>0</td>
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<td>Additional benefits</td>
<td>++</td>
<td>+</td>
<td>0</td>
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<tr>
<td>Additional costs</td>
<td>++</td>
<td>0/-</td>
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<tr>
<td>Perceived risk of tainted meat</td>
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<td>0</td>
<td>0</td>
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<td>Investment in pork supply chain</td>
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<td>Changes in pork supply chain</td>
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<td>0</td>
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<tr>
<td>Market acceptance</td>
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(1) (+ = positive, 0 = neutral, - = negative).
(2) High level of uncertainty and depending on required measures to reduce boar taint and technology (detection, genetics) to prevent consumers being confronted with tainted meat.
(3) Differs per country due to differences in production practices.

A full economic evaluation requires data that are not available yet. Moreover, the following questions should be answered to support the policy making process:

a. How should the different aspects be weighted?
b. Besides all technical evidence; how will consumers, citizens and retail organizations perceive the alternatives?
c. Which combination of measures (husbandry, genetics, and detection) to guarantee 'no risk of boar taint' is cost-effective?
d. Given the combination of measures taken, which changes are to be expected in the pork supply chain?
e. How will the potential benefits and costs be distributed over the different chain participants?

Conclusions
Despite the many remaining questions, some conclusions can be drawn already:
1. Fattening boars is related with better on-farm productivity;
2. Economic effects will differ among chains and countries;
3. Distribution of benefits and costs will differ per pork chain segment depending on the strategy applied;
4. Potential market risks of the strategy fattening boars are huge;
5. The strategy fattening boars requires an integrated approach with husbandry, detection and/or genetics;
6. Immunocastration requires limited changes in the chain. Consumer perception should be dealt with. Uncertainty about human health risks;
7. Surgical castration with anesthesia can be implemented on the short term, given sufficient availability of veterinarians, but integrity of the animal is still affected.
PIGCAS: Attitudes, practices and state of the art regarding piglet castration in Europe

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The PIGCAS project is a Specific Support Action supported by the EU within its 6th framework programme. The overall objective of the project is to provide information on pig castration that will support EU policy. The specific objectives are:

• to collect information on the attitudes of relevant stakeholders;
• to collect information on the practice of pig castration;
• to evaluate research work and other information, in order to examine the various alternatives to surgical castration without anaesthesia and derive research priorities;
• to integrate the collected information and evaluation in a report providing support for EU policy.

The consortium comprises 10 participant organisations. Participant persons will be distributed into a core group of participant persons, an international stakeholder platform and an extended circle of participant persons. The support activities will be broken down into 4 work packages corresponding to the 4 specific objectives (WP1: Attitudes; WP2: Practice; WP3: Evaluation; WP4: Recommendations). WP1 and WP2 will be conducted in parallel during the first year of the programme. Under the supervision of regional co-ordinators, national contact people will conduct interviews of stakeholders. The collected information will be integrated at the international level and an international stakeholder seminar will be held in November 2007. From the integrated collected information and the seminar, common trends and regional variations in attitudes and practice, as well as potential clashes of interest between the categories of stakeholders will be derived. This will be used as an input for WP3, together with other available resources. WP3 will evaluate the available information on alternatives to surgical castration from various perspectives (attitudes, practice, welfare, pork quality, resource efficiency and economy). Within WP4, the information obtained from WP1, WP2 and WP3 will be integrated in a report containing support for EU policy. The most important deliverables will be the reports on practice of castration and attitudes of stakeholders (December 2007), evaluation of research (June 2008) and recommendations for research and policy support (December 2008).