Why it is so difficult to end surgical castration of boars in Europe: Pros and cons of alternatives to piglet castration

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Abstract. Entire male pigs can accumulate sex specific off odours, i.e. boar taint, caused by the testicular steroid, androstenone, and the product of microbial protein degradation, skatole, which is formed in the large intestine. To avoid the off odour of pork and to reduce male specific behaviour, farmers have traditionally castrated their male piglets surgically and the procedure is still common in most countries. As this has usually been done without any pain relief, this measure faces strong public criticism. European stakeholders committed themselves to end this practice from 2018, but today, 75% of male piglets are still surgically castrated in the EU. Pain relief during and/or after surgery is increasingly used in some Western European countries to avoid suffering of the animals, but the surgery and risk of infections remain. Alternatives without surgical castration in pork production are raising entire males or immunocastration. Entire males have the advantage of a high growth potential and a good feed conversion rate, but the risk of boar taint and welfare problems due to male behavior limit the acceptance by the pork chain. Immunocastration reduces these problems but also decreases, in part, the anabolic advantage of males. To find country-specific, tailored solutions, there is a need to bundle the research activities along the pork chain and to spread scientific information to increase the acceptance of alternatives by farmers, industry and consumers.

1. Introduction
For a very long time, farmers have been castrating their male piglets surgically without any pain relief. The practice is still common in most countries, but it is increasingly facing strong criticism because of the pain associated with the surgery. The suffering incurred by the animal during the surgical process and the following days has been well documented during the last 15 years. In 2010, European stakeholders had already committed themselves to end this practice and to develop pork production systems by 2018 that are independent of surgical castration. Even though a lot of time and effort has been expended to reach this aim, and alternatives are available, 75% of male piglets are still surgically castrated in the EU (1,2). The COST action IPEMA (Innovative Approaches for Pork Production with Entire Males) aims to establish alternatives to surgical castration in pork production in Europe and bundles the research activities along the pork chain to find tailored solutions for the different countries.

2. Why are piglets castrated?
The traditional reason for castration of boars is the presence of boar taint, an offensive odor and flavor observed in the meat from some entire male pigs. Two main compounds are held as responsible for boar taint, androstenone and skatole (3). Both compounds are lipophilic and thus accumulate in
adipose tissue of growing boars around the most common slaughter stages due to the progressing pubertal development and can lead to consumers’ complaints (4).

Androstenone, is a testicular steroid with a urine-like smell. It has biological significance as a male pheromone and is formed in parallel to the synthesis of anabolic testicular steroids in the Leydig cells.

Skatole is a metabolite of the amino acid tryptophan with a fecal odor and is synthesized in the colon by microbial degradation. Boar carcasses can have higher skatole levels in adipose tissue than barrows or gilts because the hepatic degradation of skatole is reduced, due to lower activities of CYP2E1 and CYP2A enzymes if concentrations of androstenone, testosterone or 17-β-estradiol are high (5, 6, 7, 8).

A peculiarity of one boar taint compound is that about one third of the consumers is anosmic to androstenone whereas another third of consumers is highly sensitive and rejects pork with already low androstenone concentrations (9). Such a high variability in perception does not exist for the other compound, so skatole-tainted carcasses are refused by most consumers if the levels are high (10). Early castration avoids boar taint accumulation and also prevents undesirable male aggressive and sexual behavior during the fattening period.

3. What are the alternatives?

There are currently three possible alternatives with practical relevance: surgical castration with anesthesia and or analgesia, raising entire males, and immunocastration. Castration with chemicals injected in the testes is too painful to be considered and sperm sorting for producing only males is not practically feasible at a large scale in the pig species (11, 12).

During recent years in Western Europe, some kind of pain relief during and/or after surgery is increasingly used due to societal and market pressure.

Since the 1960s, farmers have been raising entire males in the UK and Ireland. Castration was also abandoned in Spain and Portugal for mainstream standard pig production, while it is still performed in the high quality production systems. Entire male pigs now constitute a sizeable part of pig production in the Netherlands, Belgium, Germany, and France.

Immunocastration has been developed to a significant degree only in Belgium. In most Eastern European countries, piglet castration is not an issue yet, although immunocastration is under consideration to reduce feed costs and fat content. (13, 14)

3.1 Surgical castration with pain relief during and/or after surgery

General anesthesia is effective in preventing pain during castration but not in relieving post-operative pain. Conversely, analgesia is effective post-surgery but not during it. Only combined anesthesia and analgesia is fully effective for pain avoidance, but it is a costly procedure, especially if vets are required. General anesthesia for piglet castration is administered via inhalation (CO$_2$, isoflurane) or intramuscularly (Ketamine). CO$_2$ is cheap but aversive to the animal (11, 12). Isoflurane is efficient but costly and it can affect workers and the environment. Ketamine is risky for the animal and requires a lot of monitoring. Local anesthesia with Lidocaine injected in the testes is effective if carefully performed to avoid pain during the injection. Procaine is less efficient than Lidocaine, but in several countries Procaine is the only approved medication for local anesthesia in pigs. The main drugs used for analgesia include Meloxicam, Flunixin and Metamizole (13).

The advantages, however, are that quality problems due to boar taint or changes fatty acid composition are prevented, and the carcasses are suitable for all traditional pork products (13, 15) Additionally, management is easier and welfare higher that in entire males, as sex specific sexual and aggressive behaviors are abolished. The disadvantages are that surgery is still required and the risk of post-surgical wound infections persists (16). Also the anabolic potential of barrows is about 10-20% lower than that of boars, and the barrows’ feed consumption is high. Thus, a total of 10 to 15% more feed is required to produce the same amount of meat from barrows than from boars, and nitrogen excretion is about 15% higher than in entires (13, 18).
3.2 Entire male pigs
Leaving the male pigs entire avoids a cumbersome job, and is highly efficient later on, as anabolic testicular steroids increase feed efficiency and muscle content of the carcass as well (13, 18). However, it also has drawbacks. Some farmers have difficulties in managing the more restless entire males, which exhibit mounting and aggressive behavior. The long-lasting reduced welfare of the animals harassed by their dominant pen mates is to be compared with the short duration acute pain experienced by all animals during castration. Penile injuries are also quite common (14, 19, 20, 21). The increased activity of entire males in the pre-slaughter period results in more frequent carcass lesions and dark-firm-dry (DFD) meat. Lower fat content and increased fat unsaturation are detrimental for processing dry-cured products (13, 15). Finally, the occurrence of boar taint is a serious potential risk for consumer satisfaction (10,22, 23). Processing – except dilution with untainted meat – has only limited effects on increasing the quality of the final product, as further explained in specific contributions at this meeting.

Boar taint of carcasses can be reduced to some extent using a combination of genetic, dietary and management methods. For example, skatole can be efficiently controlled by feeding measures, such as the addition of inulin to the feed, but these measures are not yet efficient in controlling androstenone levels and, thus, do not guarantee boar taint-free populations (24, 25). Genetic selection for low boar taint levels has already been included in some breeding programs. Although the heritability of both androstenone and skatole levels allows efficient selection of low boar taint lines, the interdependence with the regulation of fertility traits and growth has to be considered. New techniques and strategies are promising but do not provide a rapid solution (26, 27, 28). Also transport and treatment before lairage have significant effects in boar taint compounds in the carcass of entire males, so the effort of all preceding management steps can be spoiled by inappropriate handling and transport (29). On-line assessment of boar taint is possible, with additional costs (30). The “human nose” method is simple and cheap but its effectiveness in protecting consumers from dissatisfaction is not documented in scientific publications (31). Instrumental methods are close to the market (30).

3.3 Immunocastration
Two shots of anti-GnRH vaccination in at least a 4-week interval are required to effectively postpone sexual development and decrease boar taint. Male pigs are vaccinated at least twice (at an age of 8-12 weeks and 4 to 6 weeks before slaughter) during the fattening period to suppress the hypothalamic pituitary gonadal axis (32, 33). The vaccination results in production of antibodies against the hypothalamic hormone GnRH, which is a key hormone in the endocrine cascade regulating testicular functions. From a few days after the second vaccination, testosterone secretion ceases and the animals behave like castrates and increase their feed intake (33,34). The advantages are improved welfare by circumventing many of the concerns with physical castration methods. A major benefit of immunocastration is preventing the pain associated with the castration procedures and the risk of wound infection. Additionally, the behavioral effects and a reliable reduction of boar taint compounds favor this measure (19). The disadvantages are that additional costs for the vaccine have to be considered and feeding costs and carcass quality are only intermediate between those observed in entire males and castrates (13, 18, 35). The longer the delay between the second vaccination and slaughter, the closer the performance is to that of castrates (36). Immunocastration is common in Oceania and South America, but its development in Europe is still impaired by a strong reluctance from chain actors, based on assumed rejection of the practice by the consumers (13, 14). The main argument is an irrational fear that consumption of pork from immunocastrates could affect human fertility. The safety for consumers, however, is well documented (37, 38). The antigenic GnRH fragment of the vaccine has only a potency of 0.2% on LH-release when compared to injections of the decapeptide. The carrier protein is used also for other vaccines and has no toxic neither hormonal activity. The construct of the GnRH-fragment conjugated to the carrier protein has no hormonal activity at all, not if it is administered orally and nor if it is injected. Thus, the only fact-based risk is the accidental self-injection of the person applying the vaccine. As a second vaccination is crucial for
successful immunocastration, the on-farm risk seems to be manageable. Irrespective, fact-based communication about the pros and cons of immunocastration are required to prevent adverse farmer and consumer reactions.

4. Conclusions
The castration issue is a good example of conflicting aims in pork production and needs scientific progress and good communication along the pork chain to find country–specific, tailored solutions. Whereas in the declaration of Brussels, stakeholders of the pork chain committed themselves to end surgical castration, today, 75% of male piglets are still surgically castrated. The main reasons are that quality and welfare problems of entire male pigs have not been solved reliably. To reduce the welfare problems, pain relief during and/or after surgery is increasingly used in some Western European countries. However, the surgery and risk of infections remain. Alternatives without surgical castration in pork production are raising entire males or immunocastration. Entire males have the advantage of a high growth potential and a good feed conversion rate, but the risk of welfare problems, in addition to quality problems due to boar taint and adipose tissue composition, limit the acceptance by the pork chain. Immunocastration reduces these problems but also decreases, in part, the anabolic advantage of males. To find country-specific, tailored solutions, there is a need to bundle the research activities along the pork chain and to spread scientific information to increase the acceptance of alternatives by farmers, industry and consumers.

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