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CASTRATION IN MALE PIGS: TECHNIQUES AND ANIMAL WELFARE ISSUES

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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.

Key words: *castration, lean meat, gonadotropin-releasing-hormone, androstenone*

INTRODUCTION

Surgical castration (gonadectomy) of young male pigs is an animal husbandry procedure that has been practiced for centuries in pig farming world-wide. It is estimated that about 100 million piglets are castrated annually in the 25 countries of the European Union (EU). Only few countries have abandoned castration totally (UK, Ireland) or partly (Spain and Portugal about 60% and Denmark about 5% of males that are left entire). The indications for castration include reduction of aggressive male behavior, ease of management and prevention of the occurrence of boar taint, a distinctive unpleasant odor/flavor which can be perceived during cooking/eating of meat from entire male pigs. The main compounds responsible for boar taint are androstenone, a testicular steroid that accumulates in fat tissue exhibiting a urine-like odor and skatole, a product of tryptophan breakdown in the gut exhibiting a fecal-like odour (1). Skatole is not entirely male-specific and can be suppressed by dietary means and special housing conditions (2). Not withstanding dietary or housing manipulations non-castrated boars will generally have 5-10% of individual boars with a fat skatole concentration above the sensory threshold of 0.2 µg/g fat (3). Higher skatole levels in some genetically predisposed boars might be caused by the involvement of androstenone and other testicular steroids in the regulation of skatole metabolism (4).

Status quo

According to EU Commission Directive (2001/93/EC) piglets may be castrated without anesthesia within the first week of life. If castration is practiced after the seventh day of life, it shall only be performed under anesthesia and additional prolonged analgesia by a veterinarian. Different regulations exist in some non EU-countries. In Switzerland, surgical castration is still allowed to be performed by farmers without anesthesia within the first 2 weeks of life but meanwhile the Swiss parliament decided (June 2005) to forbid castration without prior anesthesia starting in 2009. In Norway, all piglets must be castrated by a qualified veterinarian under anesthesia and a new law has been accepted to ban castration by 2009. Banning surgical castration is also envisaged in Belgium and the Netherlands. Cutting and/or tearing of tissue (scrotum and spermatic cords) are known to induce acute pain and stress and evidence exists that pain-related endocrine and behavioral alterations may persist until 4 days after castration (5). For that reason it is not surprising that animal welfare organizations are increasing the pressure on pig producers and stakeholders to ban castration without anesthesia and to encourage the development of more acceptable and welfare-orientated production systems.

Surgical castration with anesthesia

Improving the technique of surgical castration with either general and/or local anesthesia in piglets of all ages (as in Norway) will certainly reduce acute pain during castration but does not eliminate stress and discomfort due to catching and handling the animals before surgery nor will it prevent the chronic post-castration pain. Performing general anesthesia is expensive, time consuming, not very effective in relieving pain and represents a risk for both, people and piglets (6). Castration with lidocaine given either intratesticularly or into the scrotal sac has been shown to successfully reduce pain-related hormonal (7) and behavioral responses (8). For prolonged control of analgesia NSAIDs have not yet documented their efficacy.

Societal and producer benefits from not castrating

On a global scale, animal welfare and pain aside, there are very compelling social reasons for seeking an alternative to surgical castration to manage boar taint. The industries increasing requirement for feed-grain to meet growing global production will mean that the swine industry must become more energy efficient and environmentally conscious.

Based on results of many studies (9 - 11) raising intact male pigs has several advantages when compared to castrates. Most obviously pain is avoided and the animal's integrity maintained. The presence of natural anabolic steroids means better feed efficiency, less food-grain consumption and reduced nitrogen and manure output, thereby lowering the risk of environmental pollution. They also grow faster with a higher lean meat yield and low carcass fat.. Additional cost savings for the producer are due to elimination of labour involved in castration and avoiding any animal losses. However, in the absence of an alternative to the control of boar taint surgical castration remains the standard global practice.

Disadvantage with boar production

The most important limitation of raising entire male pigs is the incidence of boar taint, ranging from 10 to 75% (12) and causing a high proportion of carcasses to be unsuitable for many consumers. Other disadvantages of entire male pig production include increased aggressive behavior and sexual activity resulting in skin (carcass) damage and leg problems which progressively increase as the pig reaches the latter stages of puberty. Several weeks of anxiety, stress and aggression must be weighed against the welfare problems connected to the acute stress, anxiety and pain associated with the castration process. Fighting during formation of new hierarchy also affects the levels of testosterone, androstenone and skatole (13).

Techniques to manage boar taint in entire male pigs
Screening carcasses

Results from international studies (14, 15) have shown that the majority of consumers prefer female or castrate pork compared to entire male pork. Taking into account that both, androstenone and skatole, similarly contribute to boar taint (16) and considering the large differences in consumer sensitivity to these compounds (country, male/female, anosmia), an accurate on-line sorting method is absolutely necessary to identify tainted carcasses.

There are rapid on-line tests for skatole that the Danish industry has developed and used with some success to reduce the impact of skatole. Major research programs are underway in Norway and Switzerland aimed to develop a similar test for androstenone, but at this stage, a quick, cheap and reliable method for boar taint detection on the slaughter-line is not yet a practical option. In addition, such a system requires clear cut-off levels which in face of poor correlations between skatole and androstenone and odour intensity on the one hand and carcass weight on the other will only arbitrary be defined (17, 18).

The major problem with pre or post slaughter screening is what to do with the variable percentage of carcasses that will exceed thresholds. At common slaughter weights of 22-26 weeks of age approximately 20-50% of boars will have either androstenone and/or skatole above the sensory thresholds. This proportion is too high to direct into processed products.

Semen sexing

Semen sexing is an emerging technology that has the potential to eliminate the need for surgical castration and improved animal welfare by raising predominantly female pigs. However, to date semen sexing through flow cytometry ist still in the experimental stage and is not commercially viable. Currently, this method allows the sorting of only 15 million sperm per hour or a production time of several days when using ordinary insemination techniques (19). Speed of separation, viability of sorted sperm and reduction of cost need to be improved in order to become a practical tool for AI with sexed sperm. However, when raising only female pigs the technology does little to ameliorate production efficiency and effluent management. The female pig, like the surgical castrate, is less energy efficient and produces less lean meat per carcass than the intact boar. If sex preselection ever became commercially viable in swine, industry would be better placed in terms of global production efficiency to use it to raise predominantly male pigs. The issue of this is again boar taint.

Immunological castration

One promising alternative to surgical castration as a method of controlling boar taint that has been researched for many years (16, 20, 21) is active immunization against gonadotropin releasing hormone (GnRH). Immunological castration uses the pig’s own immune system to suppress GnRH and thus shut down the stimulus to the testes resulting in a temporary inhibition of testicular function. The advantages of this technology, commonly referred to as immunocastration, are quite clear: producers are able to grow non-castrated boars with all the production, welfare and environmental benefits associated with the boar and yet still able to produce the same high pork eating quality or palatability of surgical castrates and female pigs (22). In a recent field study by Jaros *et al.* (2005) (23) using 270 pigs immunized with Improvac (Pfizer Animal Health) and 263 surgical castrates, the androstenone concentrations between both groups were not significantly different (*Table 1*). The majority of immunocastrates were far below the boar taint threshold of 0.5 µg androstenone/g fat and more than 90% had no androstenone-related odour. Immunized animals had a better daily growth rate and the average yield of lean meat was significantly improved when compared to surgical castrates.

Table 1. Concentrations and scores of androstenone, growth performance and lean meat in surgical castrated (SC) and immunocastrated pigs (IC) at slaughter (Jaros *et al.*, 2005).

		SC *n*=263	**IC *n*=270**	***P***
Androstenone (µg/g fat)	Mean	0.042	0.058	0.111[α]
	LCL[β]	0.041	0.044	
	UCL[β]	0.044	0.071	
	SD[β]	0.013	0.109	
Androstenone scores 0–4[χ] *n* (%)	0	259 (98.5)	243 (90.0)	0.000[δ]
	1	4 (1.5)	18 (6.7)	
	2	0 (0.0)	5 (1.8)	
	3	0 (0.0)	4 (1.5)	
	4	0 (0.0)	0 (0.0)	
Growth performance (kg/day)	Mean	0.817	0.827	0.353[α]
	LCL	0.804	0.814	
	UCL	0.830	0.840	
	SD	0.107	0.107	
Lean meat (% of carcass weight)	Mean	53.76	54.50	0.000[α]
	LCL	53.53	54.26	
	UCL	54.00	54.73	
	SD	1.919	1.960	

[α] Mann–Whitney *U*-test, two-sided.
[β] LCL=lower 95% confidence limit; UCL=upper 95% confidence limit; SD=standard deviation.
[χ] 0=none, 1=negligible, 2=little, 3=modest, 4=distinct.
[δ] Chi Square-test; percentages are given between brackets.

REFERENCES

1. Bonneau M. Compounds responsible for boar taint, with special emphasis on androstenone: A review. *Livest Prod Sci* 1982; 9: 687-705.
2. Claus R, Weiler U, Herzog A. Physiological aspects of androstenone and skatole formation in the boar – a review with experimental data. *Meat Sci* 1994; 38: 289-305.
3. Bonneau M, Le Denmat M, Vaudelet JC, Veloso-Nunes JR, Mortensen AB, Mortensen HP. Contributions of fat androstenone and skatole to boar taint: I. Sensory attributes of fat and pork meat. *Livest Prod Sci* 1992; 32: 63-80.
4. Babol J, Squires EJ, Lundström K. Relationship between metabolism of androstenone and skatole in intact male pigs. *J Anim Sci* 1999; 77: 84-92.
5. Hay M, Vulin A, Génin S, Sales P, Prunier A. Assessment of pain induced by castration in piglets: behavioral and physiological responses over the subsequent 5 days. *Appl Anim Behav Sci* 2003; 82: 201-218.
6. Jäggin N, Kohler I, Blum J, Schatzmann U. Castration of newborn piglets under inhalation anesthesia with halothane. *Prakt Tierarzt* 2001; 82: 1054-1061.

7. Prunier A, Hay M, Servičre J. Evaluation et prevention de la douleur induite par les interventions de convenance chez le porcelet. *J Recherche Porcine (France)* 2002 ; 34: 257-268.
8. Marx G, Horn T, Thielebein J, Knubel B, von Borell E. Analysis of pain-related vocalization in young pigs. *J Sound Vibr* 2003; 266: 687-689.
9. Vahlun S. Rearing of boars in Denmark. *Fleischwirtschaft* 1993; 73: 445-448.
10. Andersson K, Schaub A, Andersson K, Lundström K, Thomke S, Hansson I. The effect of feeding system, lysine level and gilt contact on performance, skatole levels and economy of entire male pigs. *Livest Prod Sci* 1997; 51: 131-140.
11. Xue JL, Dial GD, Pettigrew JE. Performance, carcass and meat quality advantages of boars over castrates: a literature review. *Swine Health Prod* 1997; 5: 21-28.
12. Xue J, Dial GD, Holton EE, et al. Breed differences in boar taint: relationship between tissue levels of boar taint compounds and sensory analysis of taint. *J Anim Sci* 1996; 74: 2170-2177.
13. Giersing M, Lundström K, Andersson A. Social effects and boar taint: Significance for production of slaughter boars (Sus scrofa). *J Anim Sci* 2000; 78: 296-305.
14. Bonneau M, Walstra P, Claudi-Magnussen C, et al. An international study on the importance of androstenone and skatole for boar taint: IV. Simulation studies on consumer dissatisfaction with entire male pork and the effect of sorting carcasses on the slaughter line, main conclusions and recommendations. *Meat Sci* 2000; 54: 285-295.
15. Matthews KR, Homer DB, Punter P, et al. An international study on the importance of androstenone and skatole for boar taint: III. Consumer survey in seven European countries. *Meat Sci* 2000; 54: 271-284.
16. Bonneau M, Dufour R, Chouvet C, Roulet C, Squires EJ. The effects of immunization against luteinizing hormone-releasing hormone on performance, sexual development and levels of boar taint-related compounds in intact male pigs. *J Anim Sci* 1994; 72: 14-20.
17. Walstra P, Claudi-Magnussen C, Chevillon P, et al. An international study on the importance of androstenone and skatole for boar taint: levels of androstenone and skatole by country and season. *Livest Prod Sci* 1999; 62: 15-28.
18. Aldal I, Andresen O, Egeli AK, et al. Levels of androstenone and skatole and the occurrence of boar taint in fat from young boars. *Livest Prod Sci* 2005; 95: 121-129.
19. Johnson LA, Rath D, Vazquez JM, Maxwell WMC, Dobrinsky JR. Preselection of sex of offspring in swine production: current status of the process and its application. *Theriogenology* 2005; 63: 615-624.
20. Caraty A, Bonneau M. The effect of active immunization againt LHRH on LH and FSH secretion and on fat androstenone levls in entire male pigs. *C. R. Acad Sci III* 1986; 16: 673-676.
21. Oonk HB, Turkstra JA, Schaaper WMM, et al. New GnRH-like peptide construct to optimise efficient immunocastration of male pigs by immunoneutralization of GnRH. *Vaccine* 1998; 16: 1074-1082.
22. Dunshea FR, Colantoni C, Howard K, et al. Vaccination of boars with a GnRH vaccine (Improvac) eliminates boar taint and increases growth performance. *J Anim* Sci 2001; 79: 2524-2535.
23. Jaros P, Bürgi E, Stärk KDC, Claus R, Hennessy D, Thun R. Effect of active immunization against GnRH on androstenone concentration, growth performance and carcass quality in intact male pigs. *Livest Prod Sci* 2005; 92: 31-38.

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