Indian J. Anim. Prod. Mgmt. Vol. 30(1-2) 1-6 (2014)

ALTERNATIVES TO SURGICAL CASTRATION IN PIGS : A REVIEW

JESSICA GAUDY
University of Warwick, School of Life Sciences
Coventry, United Kingdom
Email : red_331@hotmail.com

Received : 20.06.2014 ***Accepted : 25.07.2014***

ABSTRACT

Traditionally, male piglets are surgically castrated from a very early age to eliminate a number of undesirable characteristics, including aggressive behaviour and the presence of "boar taint." This surgical castration is often carried out within the first week of life, as several countries have laws that permit castration at this age without the use of anaesthesia or analgesia. This practice has considerable welfare implications for the piglets, and the increase in public interest in the welfare of farmed animals has many producers looking for alternatives. A large representative of interested parties within the European Union (EU) pork industry have produced a declaration for the voluntary phase-out of all surgical castration in pigs by January 1st, 2018. To accomplish this, alternative methods to surgical castration must be researched and employed on a regular basis. This review will discuss the alternatives that are currently available as well as those that are under development.

Castration of male piglets is a common practice in many parts of the world, and is carried out for two main reasons. First, there is a desire to reduce unwanted behaviours, such as fighting and mounting, to ensure the safety and welfare of the animals as well as the handlers looking after them. Second, entire male pigs produce certain biochemical compounds, most notably androstenone and skatole, which are responsible for the phenomenon known as boar taint[20,28]. These compounds produce particular flavours and smells that many humans are sensitive to, though the degree of sensitivity and response vary between individuals[6].

Recent increase in public interest in animal welfare has led to many changes in the legislation related to farm animal production, including regulations related to pig castration. Switzerland and Norway have banned the surgical castration of piglets entirely, while some countries, such as the United Kingdom, have very prescribed legislation (Welfare of Farmed Animals (England) (Amendment) Regulations 2003, Schedule 6, Part II, Paragraphs 22 and 23) stating that after 7 days of age the castration must be performed by a veterinarian with the use of suitable anaesthesia. By comparison, in the United States the professional veterinary body has put forth recommendations and guidelines on the castration of piglets, but there are no formal legal requirements for the provision of anaesthesia or analgesia[4].

In 2010, the European Commission and the Belgian Presidency invited representatives of European farmers, the EU meat industry, retailers, scientists, veterinarians and animal welfare NGOs to discuss alternatives to surgical castration. The resulting declaration outlines their plans to phase-out surgical castration of piglets in the EU, starting with the requirement for anaesthesia and analgesia for all surgical castrations from January 1st 2012 and ending with the abandonment of all

surgical castration by January 1st 2018[10]. While this declaration is purely voluntary, it has 34 signatories including the Federation of Veterinarians of Europe and numerous representative bodies of the pork industries of several EU nations.

These changes may be coming more rapidly in the western world, but the shift in public concern for animal welfare is happening on a global level and will undoubtedly begin to have effects further abroad. Therefore, it is essential for all animal health professionals to be prepared for whatever changes may lie ahead. With that goal in mind, this article will strive to cover the most up-to-date research on alternatives to surgical castration in piglets that are or may be applicable in the future.

Immunological castration

Perhaps the most promising alternative to surgical castration is the use of immunological castration in the form of a vaccine. Produced by Zoetis, the vaccine (marketed as Improvac® or Improvest®) stimulates the production of antibodies against gonadotropin-releasing hormone which leads to a temporary decline in hormone production from the testes and thus a reduction in one of the primary boar taint compounds, androstenone. Consumers within the EU have demonstrated that they prefer this method over surgical castration with anaesthesia and are happy to purchase pork from animals that have received the vaccine[28]. It has been reported[12]. that, following vaccination, intact male pigs became less aggressive and were quite similar in behaviour and temperament to pigs that had been surgically castrated. They also found that immunologically castrated animals vocalized less and had fewer down/dead animals during handling and transport. These findings suggest that the vaccine can reduce the aggressive behaviours that can lead to handling and welfare risks associated with intact boars, and are supported by other studies[1].

Several studies have found that immunologically castrated pigs also spend more time feeding than intact boars[12,29,9]. Meta-analysis on numerous studies[9] and found that immunocastration resulted in a significant increase in feed intake (+420 ± 35.5 g/day), feed conversion rate (+0.47 ± 0.03), backfat (+4.6 ± 0.32 mm) and carcass weight (+2.6 ± 0.59 kg) in the last 4-6 weeks of the finishing period. In terms of carcass composition, it has been demonstrated that immunological castration does have an effect on lipogenic enzyme protein expression, leading to altered levels of fatty acid production that are still quite similar to an intact boar[16]. The carcass of a vaccinated pig is also altered, producing a slight decrease in overall carcass yield that has been attributed to the presence of male sexual organs, as well as variations in gut fill and visceral organ weight[7]. These changes, however, did not have a negative impact on the quality of the meat or the cutability of the carcass.

Diet

While androstenone is a testicular steroid hormone, skatole is a by-product of microbial fermentation within the intestinal tract. Therefore, in light of the shift away from surgical castrations, the possibility of decreasing skatole production with dietary manipulation has become a well-researched area. Various feed additives have been found to have an effect on skatole levels, including raw potato starch[31,21], sugar beet pulp[15] and *Cichorium intybus* L., commonly known as chicory[2]. However, these studies have produced inconsistent results on whether or not this reduction in skatole resulted in a reduction in the overall detection of boar taint by consumers. Thus, though the theory of reducing skatole production through dietary manipulation is sound, whether it has an over-riding effect on reducing boar taint has yet to be determined conclusively.

Housing Management

Various environmental and management protocols employed on a farm have demonstrated an impact on a pig's behaviour[5,23,17], so it is not unreasonable to hypothesize that certain protocols may be effective at reducing unwanted boar behaviour, and perhaps at reducing the production of boar taint. A recent study in France[22] demonstrated a reduction in skin lesions in finishing boars that were kept in an environment that provided indoor and outdoor space versus a conventional all-indoor housing system. This study also found that boars reared in the autumn exhibit greater puberty-related changes, such as increased plasma testosterone and oestradiol, increased fat skatole and increased weight of testes, and that there was an association seen between increased mounting behaviour, increased production of sexual hormones, and an increase in the production of boar taint compounds[22]. However, Prunier et al did not find any association between levels of boar taint and the housing system in which pigs were kept or the season in which they were reared. So while this study gives some possibilities on how to reduce unwanted behaviour, it does not address the issue of boar taint.

A survey study in the Netherlands[25] gathered information from 90 pig finishers relating to their farm management and compared the various principles employed to the level of boar taint found in boars sent to slaughter from their farms. Their results show that there is an association between reduced group sizes, reduced pen area per animal, newer housing equipment, a >6 hour fasting period before slaughter, higher stocking weights and a consistent diet regime all potentially contributed to a decrease in production of detectable boar taint[25]. They also found that animals from certain genetic lines were more likely to produce detectable boar taint, but this will be discussed further in the next section. Overall, their study was well designed, though the authors readily point out the flaws of self-reporting by farmers and that there is no research to verify causality in any of these associations. However, the data does provide a general indication of which areas may benefit from further research.

Breeding

Heritability of skatole and androstenone have been estimated at 0.37-0.41 and 0.47-0.67 respectively[11], which means that making breeding selections to decrease their production would be feasible. It has been documented in multiple studies that there are variations between breeds of pig in their average levels of skatole and androstenone production[3,11,13], though it has been found by Haugen (2009) that there is considerable variability between individuals within a breed and within the breed when raised in different countries. Modern genomic testing has provided the means to evaluate the potential genetic impact of breeding selections without having to wait for numerous generations of offspring. Other worker[13] found that the most effective way to make genetic improvement was through biopsy-based performance testing of live boars. This method involved taking subcutaneous fat samples from the neck region and comparing the levels of boar taint compounds within the sample with those found in the animal's sire as well as 30 of its siblings. Testing did incur a cost of 230 euros per animal, but it was estimated that the levels of androstenone, skatole and indole could be reduced by 50% within 6-8 years. Earlier worker[13] found some consequences with selection for reduction in boar taint, including negative effects on average daily gain, drip loss, and intramuscular fat. Given that androstenone is produced within the testicle, it is also possible that selection for reduction of this hormone may have an effect on other sexual hormones, and thus an effect on reproduction (Grindflek et al, 2011). These negative effects

should be taken into consideration when making genetic selections for the reduction of boar taint compounds.

Sexed Semen

The ability to produce only female offspring would be a way to avoid raising unwanted boars, but as of yet this is not a possibility. While the technology exists to differentiate spermatozoa based on their chromosomal content, and thus to produce semen with a high probability of producing offspring of a given gender, this technology has not been implemented successfully in the pig industry. This is for numerous reasons, most notably because of the time required to perform the separation, the susceptibility of pig spermatozoa to damage during handling and storage, as well as the large concentration of spermatozoa required for artificial insemination (on average $1x10^9$/ml). Several studies have looked at making alterations in the sorting, handling and storage procedures[24,19,30,18] but research is still on-going. There are individual variations between boars that can affect the survival of sperm during handling and storage, which adds further complications to the situation[19]. However, the work done[30] shows promise in the use of antioxidants to improve sperm viability, but the results must be interpreted in the knowledge that there was no successful control AI trial for comparison. Similarly, other worker[18] found higher in vitro fertility rates when egg yolk was added to the collection media and EDTA added to the sheath fluid just before separation. Ultimately, this technology would be very useful to the pig industry and the research being done is making forward progress, but at the moment there is no verified protocol to create an economically viable product.

CONCLUSION

Extensive research has been done in this field in recent years, most likely related to the decisions being made by producer organisations in Europe to phase out surgical castration. While there have been numerous advances in both knowledge and method, immunological castration stands to make the most impact in the immediate future. That does not mean we should abandon these other methods, as many of these studies have demonstrated potential benefits to both pig production and welfare standards if further research can be done to make them into viable alternatives.

REFERENCES

1. Albrecht, A.K., grosse Beilage, E., Kanitz, E., Puppe, B., Traulsen, I., Krieter, J. (2012). Influence of immunisation against GnRF on agonistic and mounting behaviour, serum testosterone concentration and body weight in male pigs compared with boars and barrows. *Applied Animal Behaviour Science*. 138, 28-35.
2. Aluwé, M., Langendries, K.C.M., Bekaert, K.M., Tuyttens, F.A.M., De Brabander, D.L., De Smet, S., Millet, S. (2013). Effect of surgical castration, immunocastration and chicory-diet on the meat quality and palatability of boars. *Meat Science*. 94, 402-407.
3. Aluwé, M., Millet, S., Bekaert, K.M., Tuyttens, F.A.M., Vanhaeke, L., De Smet, S., De Brabander, D.L. (2011). Influence of breed and slaughter weight on boar taint prevalence in entire male pigs. *Animal*. 5:8, 1283-1289.
4. American Veterinary Medical Association. (2014). *Swine Castration.* Available: https://www.avma.org/KB/Policies/Pages/Swine-Castration.aspx. Last accessed 28th May 2014.
5. Beattie, V.E., O'Connell, N.E., Moss, B.W. (2000). Influence of environmental enrichment

on behaviour, performance and meat quality in domestic pigs. *Livestock Production Science*. 65:1-2, 71-79.

6. Blanch, M., Panella-Riera, N., Chevillon, P., Fonti Furnols, M., Gil, M., Gil, J.M., Kallas, Z., Oliver, M.A. (2012). Impact of consumer's sensitivity to androstenone on acceptability of meat from entire male pigs in three European countries: France, Spain and United Kingdom. *Meat Science.* 90, 572–578.

7. Boler, D.D., Puls, C.L., Clark, D.L., Ellis, M., Schroeder, A.L., Matzat, P.D., Killefer, J., McKeith, F.K., Dilger, A.C. (2013). Effects of immunological castration (Improvest) on changes in dressing percentage and carcass characteristics of finishing pigs. *Journal of Animal Science*. 92:1, 359-368.

8. Brewster, V., Nevel, A. (2013). Immunocastration with Improvac™ reduces aggressive and sexual behaviours in male pigs. *Applied Animal Behaviour Science*. 145, 32-36.

9. Dunshea, F.R., Allison, J.R.D., Bertram, M., Boler, D.D., Brossard, L., Campbell, R., Crane, J.P., Hennessy, D.P., Huber, L., de Lange, C., Ferguson, N., Matzat, P., McKeith, F., Moraes, P.J.U., Mullan, B.P., Noblet, J., Quiniou, N., Tokach, M. (2013). The effect of immunization against GnRF on nutrient requirements of male pigs: a review. *Animal*. 7:11, 1769-1778.

10. European Commission. (2010). *European Declaration on alternatives to* surgical *castration of pigs*. Available: http://ec.europa.eu/food/animal/welfare/farm/initiatives_en.htm. Last accessed: 28th May 2014.

11. Grindflek, E., Meuwissen, T.H.E., Aasmundstad, T., Hamland, H., Hansen, M.H.S., Nome, T., Kent, M., Torjesen, P., Lien, S. (2011). Revealing genetic relationships between compounds effecting boar taint and reproduction in pigs. *Journal of Animal Science*. 89, 680-692.

12. Guay, K. Salgado, G., Thompson, G., Backus, B., Sapkota, A., Chaya, W., McGlone, J.J. (2013). Behavior and handling of physically and immunologically castrated market pigs on farm and going to market. *Journal of Animal Science*. 91:11, 5410-5417.

13. Haberland, A.M., Luther, H., Hofer, A., Tholen, E., Simianer, H., Lind, B., Baes, C. (2014). Efficiency of different selection strategies against boar taint in pigs. *Animal*. 8:1, 11-19.

14. Haugen, J.E. (2009). The boar taint case: need for standardisation and harmonisation. Proceedings of the 55th International Congress of Meat Science and Technology, Copenhagen, Denmark. 16–21.

15. Jensen, M.T., Cox, R.P., Jensen, B.B. (1995). Microbial production of skatole in the hind gut of pigs given different diets and its relation to skatole deposition in backfat. *Animal Science*. 61, 293–304

16. Mackay, J., Pearce, M.C., Thevasagayam, S., Doran, O. (2012). Fatty acid composition and lipogenic enzyme protein expression in subcutaneous adipose tissue of male pigs vaccinated against boar taint, barrows, and entire boars. *Journal of Animal Science*. 91:1, 395-401.

17. Melotti, L., Oostindjer, M., Bolhuis, J.E., Held, S., Mendl, M. (2011). Coping personality type and environmental enrichment affect aggression at weaning in pigs. *Applied Animal Behaviour Science*. 133:3-4, 144-153.

18. Olmo, D., Parrilla, I., Gil, M.A., Maside, C., Tarantini, T., Angel, M.A., Roca, J., Martinez, E.A., Vazquez, J.M. (2013). Handling of boar spermatozoa during and after flow cytometric sex-sorting process to improve their *in vitro* fertilizing ability. *Theriogenology*. 80:4, 350-356.

19. Parrilla, I., Olmo, D., Sijses, L., Martinez-Alborcia, M., Cuello, C., Vazquez, J., Martinez, E., Roca, J. (2012). Differences in the ability of spermatozoa from individual boar ejaculates to withstand different semen-processing techniques. *Animal Reproduction Science*. 132:1-2, 66-73.

20. Patterson, R.L.S. (1968). 5a-Androst-16-ene-3-one: Compound responsible for taint in boar fat. *Journal of Science and Food Agriculture*. 19, 31–37.

21. Pauly, C., Spring-Staehli, P., O'Doherty, J.V., Kragten, S.A., Dubois, S., Messadene, J., Bee, G. (2010). The effects of method of castration, rearing condition and diet on sensory quality of pork assessed by a trained panel. *Meat Science*. 86:2, 498-504.

22. Prunier, A., Brillouët, A., Merlot, E., Meunier-Salaün, M.C., Tallet, C. (2013). Infuence of housing and season on pubertal development, boar taint compounds and skin lesions of male pigs. *Animal*. 7:12, 2035–2043.

23. Rodenburg, T.B., Koene, P. (2007). The impact of group size on damaging behaviours, aggression, fear and stress in farm animals. *Applied Animal Behaviour Science*. 103:3-4, 205-214.

24. Spinaci, M., Vallorani, C., Bucci, D., Bernardini, C., Tamanini, C., Seren, E., Galeati, G. (2010). Effect of liquid storage on sorted boar spermatozoa. *Theriogenology*. 74:5, 741-748.

25. Van Wagenberg, C.P.A., Snoek, H.M., Van der Fels, J.B., Van der Peet-Schwering, C.M.C., Vermeer, H.M., Heres, L. (2013) *Animal*. 7:11, 1841-1848.

26. Vanhonacker, F. and Verbeke, W. (2011). Consumer response to the possible use of a vaccine method to control boar taint v. physical piglet castration with anaesthesia: a quantitative study in four European countries. *Animal*. 5:7, 1107-1118.

27. Vold, E. (1970). Meat production characteristics of boars and castrated pigs Part 4 Organoleptic and gas chromatographic investigations of steam volatile material from the fat from the backs of boars. *Meldinger Nordandbruckhoegskole*. 49, 1–25.

28. Walstra, P., Maarse, H. (1970). Onderzoek geslachtgeur van mannelijke mestvarkens. Researchgroep Vlees en Vleesvare. T.N.O., Rap. C-147 and 2: 1–30. The Netherlands: Zeist.

29. Weiler, U., G•tz, M., Schmidt, A., Otto, M., Müller, S. (2012). Influence of sex and immunocastration on feed intake behavior, skatole and indole concentrations in adipose tissue of pigs. *Animal*. 7:2, 300-308.

30. Xia, C., Xia, W., Yang, S., An, L., Li, X., Wu, Z., Zhang, J., Wang, Z., Tian, J. (2012). Effect of antioxidant supplementation on function and fertility of sex-sorted boar spermatozoa. *Animal Reproduction Science*. 136:1-2, 108-114.

31. Zamaratskaia, G., Babol, J., Andersson, H.K., Andersson, K., Lundström, K. (2005). Effect of live weight and dietary supplement of raw potato starch on the levels of skatole, androstenone, testosterone and oestrone sulphate in entire male pigs. *Livestock Production Science*. 93, 235–243

32. Zammarini, D., Wood, J.D., Whittington, F.M., Nute, G.R., Hughes, S.I., Hazzledine, M., Matthews, K. (2012). Effect of dietary chicory on boar taint. *Meat Science*. 91, 396-401.

★ ★ ★