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Castration in the U.S. Swine Industry: Animal Welfare Implications and Alternatives

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Removal of the testicles (castration) is a prevalent procedure within the U.S. swine industry. Because only a small percentage of swine are selected for mating, the vast majority of male piglets (boars) are destined for processing (meat production) and are castrated. Boars are castrated to limit behavioral issues during rearing and to ensure appropriate meat quality by avoiding "boar taint." Behavioral issues can become serious as boars grow and mature, as they may develop aggressive tendencies toward their pen mates and attempt to mate with females in the pen. These behaviors could increase the risk of lameness and injury for both boars and their pen mates. Mature boars could also be aggressive toward farm staff. Surgical castration is the most common method of castration in the U.S. However, a relatively new option for producers is immunocastration, and some are transitioning to this. Here we discuss considerations for animal welfare, economic implications, and potential future alternatives.

Boar Taint and Meat Quality

Once boars reach puberty (approximately 5 to 6 months of age and weighing about 200 pounds), androsterone (a male pheromone) and skatole (a byproduct of intestinal bacteria and a metabolite of the amino acid tryptophan) begin to accumulate in body fat. These compounds cause the meat to have an unpleasant odor and taste, called boar taint. Not all testicle-intact boars will develop this meat quality issue. Depending on their age, breed, and environment, about 20% to 50% of intact males will produce boar taint. Boar taint is actually prohibited by food quality regulations in most countries, the U.S. included, meaning that meat with boar taint cannot be sold directly to the consumer. If any intact boar is slaughtered, its meat is further processed into products like sausage and pepperoni; cooking the meat and adding spices for such products prevents boar taint from being detected. Research suggests that approximately 75% of consumers are sensitive to and can detect boar taint in meat (AVMA 2013a). Because this is a relatively large part of the consumer population, it is necessary for producers to avoid the development of this meat quality issue.

Surgical Castration

Surgical castration is the conventional method used to avoid behavioral and meat quality issues and is the most prevalent method within the U.S. swine industry. The invasive procedure involves manual restraint of the boar, followed by two incisions on the scrotum, manual removal of the testicles, and a cut or tear of the spermatic cord. On most farms, iodine is applied to the wound to avoid infection. The entire process takes approximately 30 seconds per piglet and is typically done by trained farm staff. This option is fast, easy, and effective. Currently, castrated piglets do not receive any pain relief or sedatives; in fact, none are approved for such commercial use by the U.S. Food and Drug Administration (FDA). However, pain medication can be prescribed for "extra label use" by a veterinarian, in which a medication is used in a manner that does not appear on its approved label (Texas Tech University, n.d.). Typically, the American Veterinary Medical Association (AVMA) recommends surgical castration to be performed when boars are between 2 and 14 days of age. If the procedure is performed after 14 days of age, the AVMA recommends that pain relief (analgesia) and/or anesthesia be used. Yet at any age, the procedure causes pain.

As with any surgery, complications can occur. Some complications related to surgical castration include the development of abscesses, excessive swelling, infection, poor wound healing, and failure to remove both testicles (AVMA 2013a).

Piglets clearly show that surgical castration causes them pain. During the procedure, piglets can show behavioral resistance such as kicking and squirming and may

demonstrate high-frequency vocalizations. Immediately after, they show altered behavior and will tend to isolate from others. Physiological signs of distress in response to castration are an increased heart rate and increased circulating adrenaline, noradrenaline, and cortisol levels. In addition, piglets can experience chronic (long-lasting) pain for up to five days after the procedure.

A benefit of surgical castration is that potential aggressive behaviors do not develop as they would with intact boars. This reduces risk of injury and lameness in the castrated boars and their pen mates, so in a way surgical castration has animal welfare benefits (Bonneau and Weiler 2019). These castrated males are calmer, easier to handle, and easier to manage by farm staff.

Immunocastration: An Animal Welfare-friendly Alternative

A newer, less-invasive option to avoid boar taint is immunocastration (figure 1). An immunocastration product known as Improvest was approved by the FDA in 2011 and involves a protein compound that works as an immunization. Improvest is injected twice during the boars' lifetime and induces the production of antibodies that stop the production of compounds responsible for boar taint (AVMA 2013b). In other words, the pigs' own immune system interrupts testicular function and stops boar taint compounds from being produced.

Improvest is a prescription drug that involves two subcutaneous injections. The initial injection is given no earlier than 9 weeks of age and acts as a primer. The second dose needs to be administered 4 to 8 weeks after the first dose. Up until the second injection, the boars are still boars and will behave as such, meaning they will exhibit the same behaviors as intact boars would. Depending on the production system, a third injection may be required if the males are slaughtered at an older age. Doing this, however, is considered extra-label use and requires a prescription from a veterinarian. Overall, this process is less painful than surgical castration, but there are some welfare implications that should be considered.

The main advantage of immunocastration is to eradicate the need for surgical castration and the subsequent pain. Some disadvantages to immunocastration are that some boars may not receive both injections properly. If this occurs, the animal will not produce the antibodies needed, will continue to show the intact male-associated behaviors, and could develop boar taint. As with any injection, there is the chance that an animal will have an adverse reaction at the injection site. There is also the risk of a needle breaking off during the injection.

While the process is less invasive than surgical castration, there is a risk for the operator. Physiologically, humans and swine are very similar. Because of this, if an accidental self-injection occurs, the compounds would have the same impact on an operator as they do on a boar. However, the likelihood of this happening is fairly low. Those who administer Improvest go through safety and certification programs and use special safety applicators.

While Improvest is widely used in other pork-producing countries, it has been argued it lacks wide adoption in the United States due to lack of awareness (Rueff, Mellencamp, and Pantoja 2019). Currently, a number of Virginia-based producers use Improvest and produce intact, immune-castrated boars.

Economic Considerations

For surgical castration, the main cost is labor followed by cost of equipment. However, commercial farms will commonly castrate while performing other procedures, such as vaccinating and tail docking, which increases efficiency and thus reduces labor costs. An indirect cost to consider is feed. Castrated males need 10%-15% more feed compared to intact males to produce the same amount of meat (Pauly et al. 2012). Because surgical castration takes place when boars are much younger than if they are immunocastrated, farms that opt for surgical castration will require more feed over the life of the boar.

For immunocastration, both labor and equipment (in this case the prescription drug), are major costs ($5 per boar; Buhr et al. 2013). Administering two doses can be time-consuming and laborious, depending on the number and size of the boars. Monitoring boars for their responses to the subcutaneous injection will require additional time, increasing labor costs. An economic benefit to immunocastration that can be considered is that the vaccine and vaccination cost would be offset by the higher feed efficiency of the boars prior to the second injection compared to a surgically castrated male (Buhr et al. 2013). Up until the second injection, Improvest-treated males grow like intact males, thus they will have improved feed efficiency compared with surgically castrated males. This will also result in immunocastrated

males having more muscling and leaner meat compared to surgically castrated males. Having higher, more consistent weights at the time of slaughter can result in a higher premium for producers (Buhr et al. 2013).

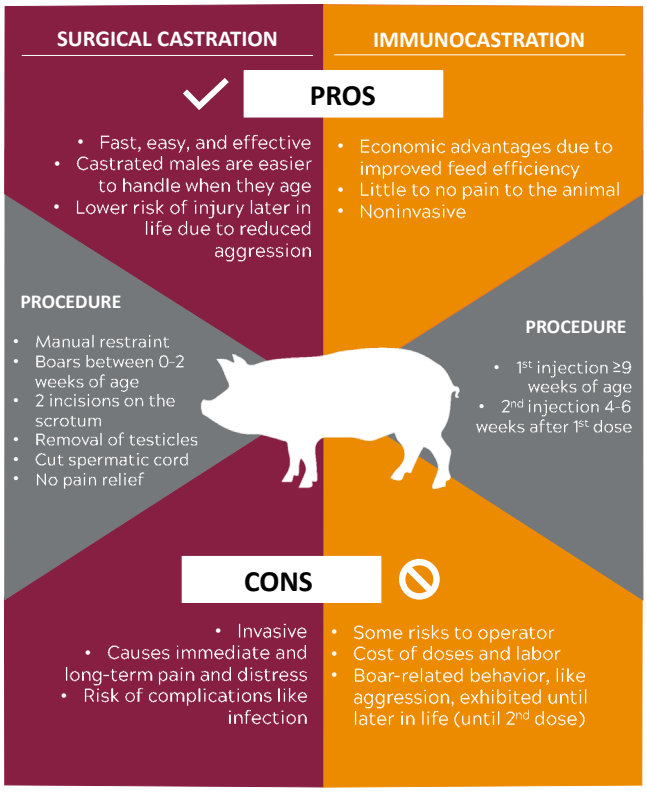

Figure 1. The infographic summarizes main advantages and disadvantages of surgical castration and immunocastration. (Image credit: Jessica Neary and Leonie Jacobs, Virginia Tech).

Consumer Demands

Few studies in the U.S. have investigated consumer demands when it comes to castration. Research from other countries shows that consumers are generally not aware that pigs are castrated or that boar taint exists. When informed, consumers expressed that surgical castration was a serious welfare concern from their perspective. Consumers showed mixed responses when they learned about immunocastration (AVMA 2013a).

Alternatives to Castration

Market pigs at a lighter weight

In Europe, several countries do not surgically castrate their boars. Great Britain and Ireland keep almost all of their boars intact and slaughter the animals at a prepubescent weight of about 200 pounds. In the U.S., market hogs are slaughtered at weights of 275 pounds or more, and if boars are harvested at these weights, tainted carcasses are likely. Slaughter costs for a 200-pound pig are similar to those of a 300-pound pig, which makes it more profitable for producers in the U.S. to slaughter at a later age (heavier weight, same cost, so more income) (Texas Tech University, n.d.). If U.S. producers were to shift to a lighter pig, consumers would have to shift their expectations for pork products (size) and prices.

Sperm sexing

Sperm sexing is commonly applied in bovine production and refers to the process by which sperm cells are separated based on whether an X or Y chromosome is present. Artificial insemination is the primary method of breeding swine in the U.S. and use of semen doses containing all X chromosome-bearing sperm cells would result in all-female litters. Although a promising technology, in the near future this may not be a realistic option in the swine industry. The current process and technology are time-consuming and expensive. So, without financially feasible technology, sexing sperm is currently not a practical option for commercial use.

Genetic selection against boar taint

A number of studies have researched genetic selection against boar taint. The production and metabolism of boar taint compounds are in part hereditary, with variability among breeds and individuals. Androsterone and skatole have moderate to high heritability and there have been attempts to select for pigs without boar taint. In some cases this resulted in reproductive problems within those genetic lines. Current research is using specific genetic markers to develop low boar taint lines (Squires and Schenkel 2010). If genetic merit for low boar taint is established and used, boar taint can be gradually reduced over several generations. Genetic merit for low boar taint can be established by simultaneously comparing biopsies, genetic markers, and slaughter line data of siblings and half siblings (Backus et al. 2016).

Breeding “castration-free” pigs

New biotechnology is being developed in the swine world. Leading companies are working to develop males that are naturally castrated. The project is still in its infancy, but in 2019 the first gene-edited “castration-free” litter was born. The project involved deleting the gene that triggers the release of hormones that initiate puberty. As a result, these pigs stay in a prepubertal state, so there is no need to castrate. The next step is to investigate the commercial viability of these castration-free pigs. Because pigs are permanently

prepubescent, the researchers need to find a method to maintain reproductive success (Foundation for Food and Agriculture Research, 2019)

Final Thoughts

Currently, the two most popular options for castration have both advantages and disadvantages to the producer. Surgical castration is fast and effective, with little risk to the handler. However, there are major concerns over the piglets' welfare because of pain. Immunocastration could be a less invasive alternative, showing clear benefits to the animal, yet not many producers are applying the method. When producers consider their options, they have to balance animal welfare and costs. The markets are volatile and low prices are a recurring issue in the industry. The goal is to find a castration method that is cost-effective, efficient, welfare-friendly, and satisfactory for consumers.

References

AVMA (American Veterinary Medical Association). 2013a. "Literature Review on the Welfare Implications of Swine Castration." May 29, 2013. https://www.avma.org/KB/Resources/LiteratureReviews/Documents/swine_castration_bgnd.pdf.

AVMA. 2013b. "Swine Policy Revised to Recognize Immunocastration." July 17, 2013. https://www.avma.org/javma-news/2013-08-01/swine-policy-revised-recognize-immunocastration.

Backus, G. B.C., E. van den Broek, B. van der Fels, L. Heres, V. M. Immink, E. F. Knol, M. Kornelis, et al. 2016. "Evaluation of Producing and Marketing Entire Male Pigs." *NJAS - Wageningen Journal of Life Sciences* 76: 29–41. https://doi.org/10.1016/j.njas.2015.11.002.

Bonneau, M., and U. Weiler. 2019. "Pros and Cons of Alternatives to Piglet Castration: Welfare, Boar Taint, and Other Meat Quality Traits." Animals 9 (11): 1–12. https://doi.org/10.3390/ani9110884.

Buhr, B., G. Tonsor, K. Zering, D. Dipietre, Cowles, B., and de Moraes, P.J.U. 2013. "Comprehensive Economic Analysis of Improvest® Adoption by the U.S. Pork Industry." Zoetis Technical Update, June 2013. https://www.zoetisus.com/products/pork/improvest/pdf/ImprovestEconomicTechnicalBulletin.pdf.

Foundation for Food and Agriculture Research. 2019. "Genome Editing Used to Birth Castration-free Prototype Piglets." National Hog Farmer. June 19, 2019. https://www.nationalhogfarmer.com/livestock/genome-editing-used-birth-castration-free-prototype-piglets.

Pauly, C., W. Luginbühl, S. Ampuero, and G. Bee. 2012. "Expected Effects on Carcass and Pork Quality When Surgical Castration Is Omitted — Results of a Meta-Analysis Study." Meat Science 92 (4): 858–62. https://doi.org/10.1016/j.meatsci.2012.06.007.

Rueff, L., Mellencamp, M. A., and Pantoja, L.G.. 2019. "Performance of Immunologically Castrated Pigs at a Commercial Demonstration Farm over 3.5 Years." Journal of Swine Health and Production 27 (6): 322–28.

Squires, E. J., and F. S. Schenkel. 2010. "Managing Boar Taint: Focus on Genetic Markers." London Swine Conference — Focus on the Future. March 2010. https://www.researchgate.net/publication/242748688_MANAGING_BOAR_TAINT_FOCU.S._ON_GENETIC_MARKERS.

Texas Tech University. n.d. "Pig Castration." Accessed June 1 2020. https://www.depts.ttu.edu/animalwelfare/research/pigcastration/index.php.

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