Chapter 9 Pig immunocastration: advances in the sustainability of pig production

Capítulo 9 Inmunocastración de cerdos: avances en la sustentabilidad de la producción porcina

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Abstract

Immunocastration, a method that uses the animal's immune system to generate antibodies against the GnRH hormone, which results in the reduction of sex hormones and, consequently, of compounds responsible for boar taint in meat. Immunocastration improves animal welfare, reduces production costs and has a positive impact on environmental sustainability. Immunocastration is an alternative to surgical castration, avoiding the pain and stress associated with this procedure. In addition, it improves the quality of meat and economic benefits for producers. But there are some challenges, such as possible side effects and variability in vaccine effectiveness between individuals. The reluctance of some markets or consumers towards meat from immunocastrated animals is also highlighted. In conclusion, immunocastration is highlighted as a promising option in animal production, with significant benefits, but the importance of addressing challenges and limitations to optimize its effectiveness and market acceptance is emphasized.

Pigs, Escatol, Testosterone, Castration

Resumen

La inmunocastración, un método que utiliza el sistema inmunológico del animal para generar anticuerpos contra la hormona GnRH, lo que tiene como resultado la reducción de hormonas sexuales y, consecuentemente, de compuestos responsables del olor sexual en la carne. La inmunocastración mejora el bienestar animal, reduce costos de producción y tiene un impacto positivo en la sostenibilidad ambiental. La inmunocastración es una alternativa a la castración quirúrgica, evitando el dolor y el estrés asociados con este procedimiento. Sin embargo, mejora la calidad de la carne y los beneficios económicos para los productores. Pero hay algunos desafíos, como posibles efectos secundarios y variabilidad en la eficacia de la vacuna entre individuos. También se destaca la reticencia de algunos mercados o consumidores frente a la carne de animales inmunocastrados. En conclusión, se resalta la inmunocastración como una opción prometedora en la producción animal, con beneficios significativos, pero se enfatiza la importancia de abordar desafíos y limitaciones para optimizar su efectividad y aceptación en el mercado.

Porcinos, Escatol, Testosterona, Castración

9 Introduction

Pork production is an important economic activity in many countries around the world (Squires et al., 2020) and its sustainability is an increasingly relevant issue. Sustainability refers to the ability to meet current needs without compromising the livelihood of future generations. In some countries, citizens are concerned about the impact of intensive farm animal production conditions on animal welfare and the environment (Kress et al., 2019). Immunocastration is a technique that has been proposed as an alternative to surgical castration of male pigs, with the aim of improving animal welfare and reducing the environmental impact of pig production.

Surgical castration of male pigs is a common practice in pig production, as it reduces taint in the meat and prevents problems with aggressive behavior and mounting (Čandek-Potokar et al., 2017). However, this activity also has some disadvantages, such as the pain and stress it causes in animals, as well as the risk of infections and other health problems (Yun et al., 2019). Surgical castration can have a negative impact on the sustainability of pig production, as it increases the environmental footprint and can affect the quality of the meat (Aráoz de Lamadrid, 2016).

Immunocastration consists of the administration of a vaccine that decreases androgen production in male pigs; this has an effect equivalent to surgical castration (Han et al., 2017). This practice has been the subject of research in recent years, and it has been shown that it can improve animal welfare and reduce the environmental impact of pork production (De Moraes et al., 2013). In this work, immunocastration and its relationship with the sustainability of pig production will be discussed. The main aspects of immunocastration will be presented, as well as the benefits and disadvantages of this technique in terms of animal welfare, meat quality and environmental footprint.

9.1 Materials and methods

This study was based on an in-depth review of the scientific and technical literature related to the topic of immunocastration of pigs and its impact on the sustainability of pig production. Literature searches were conducted in academic and scientific databases, such as PubMed, Scopus, Web of Science, and Google Scholar, using key terms such as “immunocastration,” “pigs,” “sustainability,” and “swine production.” Relevant studies were selected by reviewing the titles and abstracts in the initial searches. Studies were selected that provide substantial information on advances in pig immunocastration and its relationship to sustainability.

A synthesis of the information collected from the selected studies was carried out. Relevant findings related to pig immunocastration and its effects were organized and categorized in terms of sustainability, including aspects such as animal welfare, production efficiency and environmental impact.

9.2 Results

9.2.1 Immunocastration

Immunocastration involves activating the animal's immune system to generate specific antibodies directed against the hormone GnRH (gonadotropin-releasing hormone) (Zamaratskaia & Rasmussen, 2015). These antibodies have the ability to interfere with the normal function of GnRH, decreasing the concentrations of the hormones LH and FSH in the blood and suppressing the development and function of the testicles. As a result, the levels of androstenone and skatole in the animal's fat are reduced, which in turn reduces the incidence of boar taint in meat carcasses (Lin-Schilstra & Ingenbleek, 2022) (Figure 1).

Immunocastration takes advantage of the animal's natural immune system to achieve the effects of castration (Mancini et al., 2017). The vaccine contains an inactive version of the hormone GnRH, which is covalently linked to a carrier protein with immunogenic properties. Although this GnRH analog lacks hormonal activity, it contains the necessary characteristics to stimulate an efficient antibody response against GnRH, thereby blocking stimulation of the hypothalamic-pituitary-gonadal axis (Brunius et al., 2011). As a result, the production of gonadal sex hormones is hindered, causing regression of the reproductive organs and some associated metabolic changes. These changes ultimately translate into behavioral modifications, such as a decrease in aggression and an increase in appetite and food intake, as well as improvements in growth performance (Čandek-Potokar et al., 2017).

9.2.2 Benefits of immunocastration in animal production

Immunocastration can help improve animal welfare by avoiding surgical castration, which can be painful and stressful for animals. According to FAO (2023), animal welfare is an important pillar in animal production, as it guarantees the safety and maximum performance of animals. Immunocastration can have economic benefits for producers, as it can improve meat quality and reduce production costs. According to Casanova Lugo (2018), silvopastoral systems emerge as a sustainable technological option for livestock production, and immunocastration can be a complementary technique to improve meat quality and reduce production costs.

Immunocastration can also contribute to the sustainability of animal production, as it reduces the environmental impact of production. According to Van den Broeke et al., (2022) immunocastration can reduce greenhouse gas emissions and water and feed consumption in animal production. The evaluation of the impact of immunocastration on animal production in terms of sustainability has been carried out through different indicators, among which is animal welfare. Immunocastration is a technique that avoids surgical castration, which can improve animal welfare. According to the Argentine Journal of Animal Production (2015), immunocastration can reduce pain and stress in animals, which contributes to improving their well-being (Heyrman et al., 2019).

The environmental impact of animal production can be reduced with the use of immunocastration, since it reduces the emission of greenhouse gases and the consumption of water and feed in pig farms. According to Basulto Baker, (2020), immunocastration can contribute to the sustainability of animal production, it can also improve the quality of meat, which can have economic benefits for producers. According to Casanova Lugo (2018), immunocastration can be a complementary technique to improve meat quality and reduce production costs.

9.2.3 Challenges and limitations of immunocastration

Immunocastration also presents challenges and limitations. According to the Argentine Journal of Animal Production (2015), immunocastration can have side effects in animals, such as the formation of abscesses at the vaccination site. However, it may be more expensive than surgical castration in some cases, as the implementation of immunocastration entails additional costs, including the cost of vaccines and staff training, which may influence the profitability of pig production (Rueff et al., 2019).

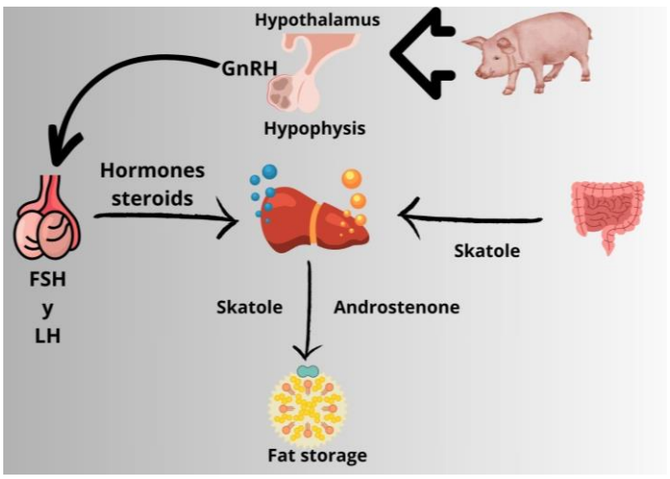
Another aspect that has limited the flourishing of immunocastration is that vaccine efficacy can be variable between individuals, meaning that some pigs may not develop a sufficient immune response to achieve effective castration because immunocastration is not a process. immediate; It takes time for the antibodies generated to completely block the action of GnRH. During this transition period, pigs may continue to exhibit undesirable behaviors and produce androstenone (Zamaratskaia & Rasmussen, 2015).

Finally, some markets or consumers may not accept meat from immunocastrated pigs due to concerns about the residual presence of antibodies or perceived changes in meat quality (Kallas et al., 2013).

9.3 Discussion and conclusions

Immunocastration is a good alternative to surgical castration in animal production; it can be used with the aim of improving the sustainability of production and reducing environmental impact. Immunocastration can also contribute to improving animal welfare and have economic benefits for producers. However, it is important to take into account the challenges and limitations of this technique and continue research to improve its effectiveness and reduce its side effects.

Figure 9 There is an interconnection between the hypothalamic-pituitary-gonadal system, the synthesis of androstenone in the testes and the transformation of tryptophan into skatole in the intestine, as well as its processing in the liver. In boars, testicular steroid production, including androstenone, has the ability to hinder the elimination of skatole in the liver. Both androstenone and skatole accumulate in adipose tissue due to their affinity for fat. Figure modified from Čandek-Potokar et al., (2017)



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