Final report

A single-shot fertility vaccine in cattle

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Prepared by:
Prof Istvan Toth (CI)
Dr Rachel Stephenson (CI)
Dr Mariusz Skwarczynski (CI)
Prof Michael D'Occhio (CI)
Dr Gry Boe-Hansen (CI)
Dr Imtiaz Randhawa (RO)
Dr Ahmed Shalash (RO)

The University of Queensland

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Meat & Livestock Australia Limited
PO Box 1961
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Abstract

The aim in this project was to develop a single-injection and long-acting anti-fertility vaccine for cattle. Based on publicly available information, current anti-fertility vaccines require at least two injections, are relatively short-acting, and can produce local site reactions and granulomas. The novelty in this project is a single-dose vaccine using the key gonadotropin-releasing hormone (GnRH) peptide antigen and nanotechnology to enhance the immunogenicity of GnRH in suppressing ovarian function and fertility in Brahman heifers. Both **Vaccine A** and **Vaccine B**, which had no safety or welfare concerns, induced an anti-GnRH antibody response in a proportion of Brahman heifers vaccinated, but the response was short-lived and was not sufficient to supress long-term ovarian activity in all vaccinated heifers. Suggestions are made for future research to refine this single-dose vaccine technology to achieve a strong and sustained anti-GnRH antibody response for long-term suppression of fertility in female cattle.

Executive summary

Background

A practical alternative to surgical sterilisation of female cattle not required for breeding remains an unmet need in the beef industry. Anti-fertility vaccines currently available require at least two vaccinations to induce an anti-fertility response, the response is variable between cattle, and the anti-fertility response is relatively short-lived. This makes the vaccines impractical in extensive beef production where there is a particular need.

Objectives

The present project evaluated whether a single vaccination with chemically defined vaccines that target specific cells in the immune system (helper T-cells) that are involved in the generation of antibodies has the potential for long-term fertility control in cattle. The two newly designed vaccines seek to induce antibodies that bind and biologically neutralise the key reproductive hormone gonadotropin-releasing hormone (GnRH).

Methodology

Vaccine A and **Vaccine B** were injected subcutaneously in the neck behind the head in two groups of Brahman heifers that were showing regular ovarian activity (n = 10/group). Another group of heifers were not vaccinated and served as controls (n = 10). Blood samples to measure anti-GnRH antibody levels were taken from all heifers immediately before vaccination and at intervals after vaccination. Ovarian activity was ascertained before vaccination and monitored at intervals after vaccination.

Results/key findings

Vaccination with **Vaccine A** and **Vaccine B** induced an anti-GnRH antibody response in a proportion of Brahman heifers and the response was short-lived. Anti-GnRH antibody levels in blood diminished at 6 months in those heifers that showed a response.

Cyclic ovarian activity continued to be monitored and did not differ for vaccinated and control heifers in the 12 months after vaccination.

Benefits to industry

The vaccines assessed in this study had no safety or welfare concerns. Both **Vaccines A** and **B** induced an antibody response but was not sufficient to suppress ovarian activity long-term in heifers. Further research is required to identify single-dose vaccine technology that achieves a strong and sustained antibody response for long-term suppression of fertility in female cattle.

Future research and recommendations

Many studies have shown that generating an immune response to endogenous antigens (e.g. hormones) is particularly challenge in cattle due to various and not fully understood factors. These likely include genetic variability in immune function and response to vaccination, such as species-specific differences in immune cell surface receptors and signalling pathways which influence the immune response and nutritional status and environmental conditions. Long-term activation of T-helper cells has a crucial role in the immune response. Thus, in **Vaccines A** and **B,** we incorporated three T-helper epitopes aiming to cover for different genetical backgrounds amongst heifers. Given the lack of a long-term antibody response in the present study to vaccination with either **Vaccine A** or **Vaccine B**, future research could include testing additional T-helper cell epitopes and larger immunogenic proteins that have multiple T-helper cell epitopes. A broader range of vaccine doses could also be tested.