Seeking Better Vaccines for Livestock

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Project Title:

DNA-based Vaccines for Livestock

Researchers:

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Preventing disease in beef cattle has many benefits, including health benefits for the animals themselves and economic benefits for the cattle producer. In today's beef cattle production, cattle are often vaccinated to prevent a number of diseases.

Vaccination stimulates the animal's immune system with an infectious agent, or components of an infectious agent, that has been modified to prevent the vaccine itself from causing the disease. The agent that stimulates the immune response is called an antigen. This disease-prevention approach has been used in humans and livestock for over 100 years.

DNA (deoxyribonucleic acid) is found in the cells of all living creatures, including bacteria and viruses, and is responsible for the transfer of genetic characteristics.While still in the experimental stage, the purpose of DNA vaccination is to protect humans and/or animals agains disease by injecting DNA from the bacteria or virus that causes the disease. DNA vaccines potentially have several advantages over traditional vaccines: they would be safer because they would not be able to inadvertently cause disease; they would give life-long immunity thus preventing the need for re-vaccination; the recipient could be vaccinated for several diseases at once; and needle-free vaccinations could be used.

The project DNA-based Vaccines for Livestock experimented with DNA vaccines for three economically important diseases of cattle: bovine herpes virus (BHV-1), bovine respiratory syncytial virus (BRSV), and bovine viral diarrhea virus (BVDV). It also sought to develop a vaccine against E.coli 0157:H7. E.coli 0157:H7 is a bacteria that does not cause disease in cattle but can cause severe illness in humans. A vaccine that could prevent cattle from shedding this bacteria would be an important development for the beef cattle industry.

Genes for the immune response-stimulating characteristics of the BHV-1, BRSV, and BVDV pathogens were successfully cloned. The genes from E. coli O157: H7 that allow the bacteria to colonize the digestive system also were cloned. Identifying and replicating these genes is an important step toward developing potential vaccines.

One component of a DNA vaccine is a bacterial DNA sequence, known as a CpG motif, which stimulates the immune system to produce antibodies when the vaccine is perceived as a threat by the animal's immune system. This project tested two DNA-based vaccines containing CpG motifs in calves – one against BHV-1 and one against BVDV.

For BHV-1, the DNA vaccine induced a strong cellular immune response that correlated positively with the number of CpG motifs that the vaccine contained.

However the DNA-based vaccine provided less protection than a traditional vaccine used as a control. Nonetheless, the experiment demonstrated for the first time that a CpG-enhanced DNA vaccine can elicit an immune response against an economically important pathogen in a large domestic species, and it provides a solid foundation for future experiments.

For BVDV, calves that received the DNA-based vaccine had less virus in nasal fluid and white blood cells when compared to control animals that received an injection of saline rather than vaccine. Thus, a DNA vaccination strategy is promising for BVDV.

The promise of DNA-based vaccines for livestock continues to evolve. This project helped advance knowledge in the field and will hopefully be a stepping-stone to the eventual commercial introduction of DNA-based vaccines for beef cattle.

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