UCD VET VIEWS
CALIFORNIA CATTLEMEN'S MAGAZINE
APRIL 2003

DNA Testing and Genomics: What's the future for beef producers?

It was 50 years ago when the double helix structure of DNA was discovered by Watson, Crick and Wilkins working in England. At that time, scientists knew this discovery would revolutionize our understanding of biology and medicine. In the recent past, farm animals have been successfully cloned. This includes the cloning of calves at California State University, Chico working in cooperation with a California beef producer. In this month's column I am going to list some of the potential benefits to beef producers of DNA testing and genomics (the science of gene manipulation).

DNA is the substance that makes up the chromosomes in all living cells. The code for the function of the cells is contained within the DNA sequences. DNA is made up of 4 base pairs (Adenine, Guanine, Thymine, and Cytosine) and these are often abbreviated as A, G, T, and C. These base pairs form combinations of three (3), such as GAT, and each combination of three base pairs codes for a different amino acid. There are about 20 amino acids and these amino acids are the building blocks of proteins. The sequence in which these amino acids are combined determines the function of each protein. In turn, the proteins are responsible for doing all the various work that needs to be done to sustain life. The DNA in the chromosomes is the blueprint for life and this blueprint can reproduce itself.

Parentage Testing

We have been able to do parentage testing in beef cattle for a number of years. Originally, we did this based on blood types. Cattle have about 20 major blood types versus the 3 major types in humans. Using the combinations of blood types, scientists have been able to identify parents (or non-parents) of calves for over 30 years. During the last 15 years DNA testing for parentage has replaced blood type testing for the most part. The number of unique DNA sequences is much greater than the number of blood types in cattle so this has given us a more precise tool for determining parentage. Seed stock producers have been using DNA testing for this purpose for some time and now commercial herds can use DNA testing to find which bulls sire the most (or best) calves in a cow herd.

Diagnostic Tools

A number of diagnostic tests have been developed based on DNA testing. Recently, researchers in the School of Veterinary Medicine and the California Animal Health and Food Safety Laboratory system (CAHFS) on the Davis campus developed a DNA-based diagnostic test to differentiate the pathogenic trichomonads that can cause infertility (early abortions; Trichomonosis) from the non-pathogenic trichomonads found in some bulls. This is particularly important when testing young virgin bulls going to sales as they can often be found to harbor the harmless trichomonads on routine "Trich" tests. Other DNA-based tests have helped to discover that a bacterium is responsible for

Foothill Abortion (EBA). More and more tests for unique DNA sequences will be developed to aid in the rapid diagnosis of many cattle diseases.

Vaccines

A vaccine stimulates a cow's immune system to develop antibodies, which protect her from disease. The important part of the vaccine is usually the unique protein(s) on the surface of the bacteria or virus. Using DNA-based techniques it becomes possible to identify the best protein(s) for the stimulation of the protective immunity. This protein can then be "cloned" and produced in greater quantity. These methods will allow scientists to make vaccines that are more specific, more effective, and cheaper. Additionally, these vaccines will have fewer side effects that could harm cattle.

Disease Investigations

Last year there was a cow that went to slaughter in California that was diagnosed as having tuberculosis. This cow was part of a mixed group of dairy and beef cows (33 total) being culled from a number of herds. The identity of this TB-infected cow was in question early on in the investigation. To help determine the identity of this TB-infected animal, CDFA initiated DNA testing of the tissues of the infected animal. This type of investigation takes a long time and is relatively expensive. However, based on the DNA testing results, it was concluded that the TB-infected cow was most likely a Holstein and not a beef animal. This type of information will be very valuable for CDFA and USDA as they continue their attempts to control bovine TB in California.

Production Efficiency

The ability of bulls to sire calves is partially determined by the presence of a protein in sperm referred to as Fertility Associated Antigen (FAA). Bulls that lack FAA can be normal in all respects (including a normal semen exam) except they don't fertilize the cow's eggs and don't sire calves. Research indicates that about 13% of bulls are in this category, FAA negative. In the near future, there will be a chute side test available to check bulls for the presence of FAA. This will be a valuable tool to cull bulls that are FAA negative. Additionally, some bulls have two copies of the gene (DNA) that codes for FAA (homozygous) and some bulls have only one copy of this gene (heterozygous). Genetic testing can be done on bulls that are FAA positive to see if all their offspring will be FAA positive or only a percentage will be FAA positive.

The examples above are just a few of the ways DNA testing and genomics are starting to "pay off" for beef producers. More tools will become available to help us make better decisions.

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