

The quality of beef and consumer preferences

Genomic research is addressing consumers demand for a high quality of beef, in the view of Mateescu's Animal Genetics and Genomics Lab

Consumers evaluate the quality of beef at the point of purchase with respect to freshness, marbling, colour and other attributes, and at the point of consumption where the focus is on quality of eating experience, or palatability. The eating experience is an important factor guiding consumers' attitude toward a particular food and the ability to deliver a consistently superior eating experience we believe is important if the beef industry is to maintain or expand its share of the market.

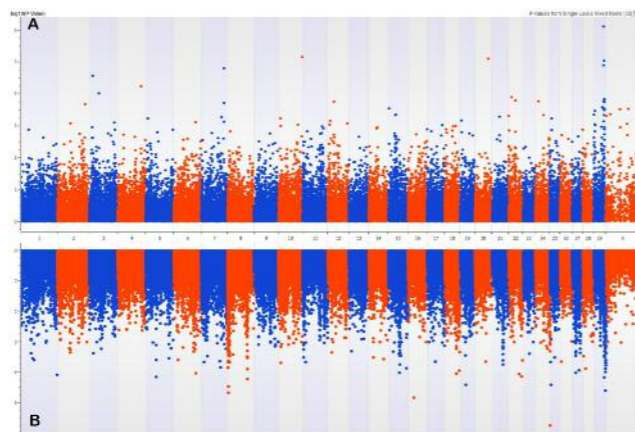


Figure 1. Genome wide association results for tenderness in two different beef cattle populations. Manhattan plots from beef cattle genome-wide association study for tenderness measured by Warner-Bratzler shear force in an Angus population (panel A) and AngusxBrahman crossbred population (panel B). Each dot represents one SNP across all 29 chromosomes of the bovine genome.

There is an opportunity here for the beef industry to respond to consumers through an increased emphasis on producing beef of high quality, nutritional value and healthfulness. In addition, selection is an obvious option to generate a permanent and cumulative improvement of these traits.

Current evaluation system for quality of beef

The USDA (U.S. Department of Agriculture) grading system established in 1996, was designed to separate beef carcasses into groups with uniform quality. In the absence of any other system to predict eating quality, the beef industry is using the USDA grading system based on marbling and maturity as an indicator of palatability of the meat from a beef carcass.

Although the USDA grading system has served the industry well, changes in consumers' preferences, limitations

in the ability of the system to predict eating quality and limited consumer understanding of the USDA grading system are some of the shortcomings associated with the system.

Improving the eating experience when consuming beef and the ability to accurately inform the consumer of the expected eating quality when the product is purchased – are critical challenges. Meeting these challenges would increase consumers' confidence in the quality of the product and allow the industry to more accurately align the value with the quality of the product – for marketing purposes.

How can genomic tools help with evaluating and improving quality of beef?

All the components defining eating quality are quantitative traits, controlled by many genes and impacted

by environmental factors. Visual and sensory traits describing meat quality are measured post-harvest, but are difficult and costly to measure on a sufficient number of close relatives of selection candidates. These characteristics make classic approaches – based on pedigree and performance records, successfully implemented for growth and other easily measured traits – impractical for improving meat quality. Reliable genomic prediction leveraging recent developments in genome re-sequencing, genotype imputation and high-throughput genotyping all offer the only real promise to address this goal.

Genomic research for meat quality

Numerous genome-wide association studies have been performed in different *Bos Taurus*, *Bos Indicus* or crossbred beef cattle breeds, and with

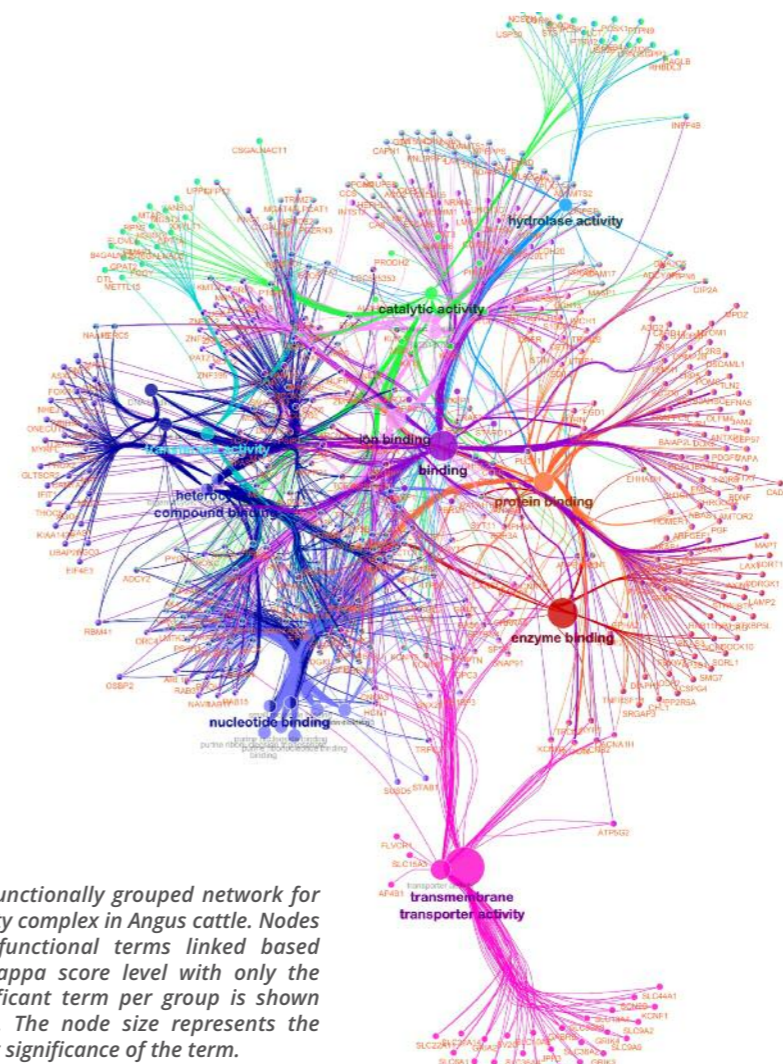


Figure 2. Functionally grouped network for meat quality complex in Angus cattle. Nodes represent functional terms linked based on their kappa score level with only the most significant term per group is shown as a label. The node size represents the enrichment significance of the term.

different phenotypes describing meat quality, from carcass characteristics to specific measures of eating satisfaction. These studies contribute to our present understanding of the genetic regulation for many of these traits, but they also highlight the challenges and limitations associated with genome-wide association studies.

Many chromosomal regions identified are unique to the specific population in which they were discovered and were not replicated in other studies. More importantly, very few functional mutations have been identified and most of the genetic variation controlling these traits remains unknown. Recently, new methodology combining traditional genome-wide association studies with gene network interactions theory has been developed to address this limitation – and allow for

a better understanding of the genetic architecture of complex traits.

Our research group used phenotypic measures of 23 traits, reflecting carcass characteristics, components of meat quality, mineral and peptide concentrations along with Illumina 54k bovine SNP genotypes to derive an annotated gene network associated with meat quality in 2,110 Angus beef cattle. The same approach was used in a different population of 673 multibreed AngusxBrahman cattle, ranging from 100% Angus to 100% Brahman genotyped with the Bovine GGP250.

The result of genome-wide association studies in these two populations (figure 1) shows that, although many chromosomal regions have a significant effect in both populations, there

are also considerable differences. These differences underscore the importance of developing the necessary genomic tools within the target population. Genomic correlated regions were identified by partial correlations and used along with an information theory algorithm to derive gene network clusters.

Correlated SNPs across all component traits were subjected to network scoring and visualisation. Significant pathways implicated in the meat quality complex through Gene Ontology term enrichment analysis – included angiogenesis, inflammation, transmembrane transporter activity and receptor activity (figure 2).

These results suggest that network analysis – using partial correlations and annotation of significant SNPs – can reveal the genetic architecture of complex traits and provide novel information regarding biological mechanisms and genes that lead to complex phenotypes, like meat quality. Knowledge of the genetics controlling these traits, along with a precise understanding of the biological networks and interactions underlying the meat quality complex, will increase the ability of the industry to improve cattle to better meet consumer expectations.



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