KEITH WELLER (K8448-2)

Can You Have Your Beef and Eat It Too?

ARS research brings healthful—and tender—beef to your table.

This Piedmontese-Hereford crossbred calf displays classic double muscling because it inherited a defective myostatin gene from both of its parents.

More than a century ago, European ranchers produced beefy, well-muscled cattle through selective breeding—without understanding how or why their genetic tinkering worked. In the 1990s, several Agricultural Research Service (ARS) scientists, after years of searching for the reason, helped pinpoint a major gene in cattle responsible for boosting muscle size and leanness.

Since then, ARS researchers have added to their understanding of this gene, which codes for the protein myostatin, with the ultimate goal of providing consumers with cuts of beef that are not only lean, but also tender. They work to provide ranchers with information and technology needed to produce such beef profitably and sustainably.

Myostatin limits muscle growth in cattle—and in humans. If the gene responsible for producing myostatin is altered so that it makes an inactive form of the protein, or the gene is intentionally suppressed, the result is more muscle and less fat. ARS researchers are working to find optimal ways to use this gene—alongside others—to make beef more healthful, without sacrificing taste and tenderness.

Love Meat Tender

A benefit of inactivated myostatin—and one likely to be popular with consumers—is beef that's more tender. "Previous researchers tested just the rib eye cut. But we found that with the altered myostatin gene, all cuts of beef have improved tenderness," says Tommy L. Wheeler, a food technologist at ARS's Roman L. Hruska U.S. Meat Animal Research Center (MARC) in Clay Center, Nebraska. Now low-quality cuts of beef, which are usually tough, can be palatable and tender.

And it's not just consumers who benefit. "Even if their cattle have just one copy of the modified gene, ranchers can experience a 7-percent yield increase in salable carcass," says Wheeler.

Production of leaner beef is also more energetically efficient. "But most cattle produced in the United States still contain nearly twice the amount of carcass fat considered optimal," says Michael D. MacNeil, an animal geneticist at ARS's

Fort Keogh Livestock and Range Research Laboratory in Miles City, Montana. This is because the current grading system pays top dollar for beef that contains more marbling—and might be more tender—despite consumer preference for lean beef. Thus, production of lean and tender beef could be a big advantage for ranchers.

Handle With Care

Myostatin manipulation seems like a promising genetic tool, but it requires a level of caution. A condition known as double muscling occurs in animals that inherit a defective myostatin gene from both parents. "Double-muscled calves are extremely muscular at birth, leading to difficulty in exiting the birth canal," says MARC animal geneticist Timothy P.L. Smith. Even after a successful birth, calves that can't produce active myostatin are less likely to survive.

Inheriting two copies of the gene producing inactive myostatin can also reduce fertility and decrease the pelvic area of females, which may further contribute to birthing problems. Double-muscled animals can also have a lower tolerance for stress. Because of these problems, some countries now ban use of cattle with double muscling.

ARS research hopes to continue to shed light on the gene, particularly in the context of beef production. "We probably know the major effects of myostatin, but some of its minor ones are still unknown," says MacNeil. One desirable approach is to cross bulls having genes that make only inactive myostatin with cows having genes that make only the active form.

The gene that codes for the inactive form of myostatin is found more often in breeds like Piedmontese and Belgian Blue. Researchers can cross these lean, well-muscled breeds with ones traditionally used for beef production, such as Angus and Hereford. The resulting animal yields beef cuts lower in saturated fat, satisfying many health-conscious consumers. These crossbred cattle also grow faster than animals that are 100 percent Piedmontese or Belgian Blue, assuring breeders and ranchers maximum returns.

M.A.R.C. (K11279-1)

M.A.R.C. (K11279-3)

M.A.R.C. (K11279-2)

Differences are apparent in lean-to-fat ratios within these cuts of meat from cattle having no (top), one (center), or two copies (bottom) of the inactive myostatin gene.

Other Ways To Get Lean

For all the benefits—and problems—associated with the myostatin gene, genetic factors contribute to only about half of what determines tenderness and leanness. Environmental and physical factors, such as feed type, length of time on feed, animal stress, carcass processing technology, and cooking methods, also factor in.

To produce more-healthful beef, researchers and breeders can also look to Limousin and Charolais cattle, which naturally have a strong genetic potential towards lean tissue. It appears that these animals achieve their leanness as a result of several genes, each exerting a small effect. ARS research is evaluating strategies to use these breeds, as well as those that produce inactive myostatin, to best meet production needs and consumer demands.

To further flesh out understanding of the genes that relate to fat deposition, MacNeil is studying animals not usually found on U.S. ranches—Wagyu cattle. This Japanese breed is associated with the highly marbled luxury known as Kobe beef, which contains up to 45 percent fat. The experimental cattle made their way to Miles City in 1999 after a research farm at Washington State University was closed.

In crossing Wagyu cattle with Limousin cattle, MacNeil, colleague Lee Alexander, and university partners created a genetic resource they can tap for more clues about the genes that play a role in deposition of fat and fatty acid composition.

Wheeler and his MARC colleagues, including Steven Shackelford and Mohammad Koohmaraie, compared Wagyu to other breeds and found that they possess carcass and meat-quality traits very similar to Angus when produced in typical U.S. production systems. Wagyu cattle not destined to become Kobe beef yield leaner carcasses than Angus and other British breeds, but they also grow more slowly and less efficiently than other breeds.—By **David Elstein** and **Erin Peabody,** ARS.

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