Predicting Tenderness and Lasting Color

If superior beef tenderness isn't enough to whet your appetite, a system that predicts both beef and pork tenderness as well as color stability in both meats may be something you can sink your teeth into.

In 2001, scientists at the Roman L. Hruska U.S. Meat Animal Research Center (USMARC) in Clay Center, Nebraska, developed a noninvasive tenderness-prediction system to identify U.S. Select beef carcasses with exceptional tenderness in the ribeye/strip loin muscle. The process, which doesn't require cooking or tasting, is based on visible and near-infrared reflectance (Vis/NIR) spectroscopy.

Though the system is commonly referred to as the "USMARC Noninvasive Beef Tenderness Prediction System," the name no longer describes its many applications. Food technologists Tommy Wheeler, Steven Shackelford, and Andy King in the USMARC Meat Safety and Quality Research Unit have shown that it is equally effective at predicting more than just tenderness—and in pork as well as beef.

Beefing Up Technology

Vis/NIR spectroscopy had been used as early as the 1950s to evaluate agricultural and other products, and it appeared to be ideal for developing technology that could predict meat tenderness without destroying valuable parts of the carcass.

"We started looking at a way to use Vis/NIR to evaluate beef—something that could operate at a rate of 400 carcasses per hour," Shackelford says. "We found a portable commercial instrument, developed repeatable ways to apply it to meat products, and then started testing its ability to predict tenderness."

The research quickly garnered collaborations with beef-processing companies and the National Cattlemen's Beef Association (NCBA), which provided grants for studies from Beef Checkoff funds.

Over the last several years, scientists have further validated their models by testing the system on more than 4,000 carcasses during grading at processing facilities.

In a recent Checkoff-funded study, Vis/NIR evaluation was conducted on the ribeye during grading, on various muscles as the carcass was cut up, and on steaks cut after aging 14 days. This study demonstrated that the technology could predict tenderness of the ribeye during carcass grading as well as the tenderness of most other major cuts of meat. It also showed that downstream processors or steak cutters could apply the technology to individual cuts of meat or steaks after aging.

"Most U.S. Select-grade beef is tender, but it's often sold at a discount relative to U.S. Choice-grade beef," Shackelford says. "This technology allows packing companies to identify U.S. Select carcasses that excel in tenderness."

Bridget Wasser, NCBA senior director of Meat Science and Technology, agrees that the industry could use technology like this to deliver more consistent beef products to the supply chain and consumers.

"Prediction of cooked-beef tenderness from raw-beef evaluation should allow industry to better funnel beef products to their best end use," she says. "Those predicted to be most tender could be valued and marketed as such."

One commercial company has implemented the technology to ensure the tenderness of its branded line of beef products.

Finding Succulent Pork Chops

What applies to beef doesn't necessarily apply to pork, but in the case of the USMARC tenderness-prediction technology, it can. Scientists have been able to modify the technique to predict pork loin tenderness.

"The pork application is a little different than beef," Shackelford says. "The way beef is presented for grading provides an opportunity to make measurements on the cross section of the loin muscle. You don't have that in pork."

With this in mind, Shackelford and his colleagues developed computer models specifically for noninvasive prediction of pork loin tenderness. By working with representatives from the National Pork Board (NPB) and other industry collaborators, they were able to successfully adapt the system and test it on pork loins at several pork-processing plants.

DAY 1 STEVEN SHACKELFORD (D2585-1)

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Beef steak color changes during simulated retail display testing.

To validate the technology, 1,800 boneless pork loins were evaluated with Vis/NIR during the boning and trimming process at commercial plants. Samples from cooked pork chops were tested and classified using slice shear force, a measure of tenderness.

"Recent NPB research has identified shear force as the predominant known factor determining pork-eating quality," says Mark Knauer, former NPB animal science director. "Therefore, successful development of a noninvasive tenderness-prediction system would allow the pork industry to develop guaranteed-tender products and improve pork-eating quality."

If the technology is adopted by the industry, product differentiation and improved genetic selection will be possible, he adds.

Color Meat Bright Red

Color is important to shoppers who consider bright-red beef or bright-pink pork as a mark of freshness and quality. But some steaks and chops turn brown earlier than others, and those might not be bought, even though they're still good.

"Only the color chemistry has changed, so it's no longer bright red or pink," Wheeler says.

"In a best-case scenario, less appealing steaks are sold at a lesser price," King says. "In a worst-case scenario, they're thrown away. Either way, that's a substantial loss."

Some research suggested that color-stability problems are mostly environmental—citing light, temperature, and packaging as major contributors to discoloration—and have little to do with animal-to-animal variation. But the USMARC team was able to show that some cattle produce beef with better color stability.

"We knew the pedigrees of these 500 animals, so we were able to attribute how much of this variation in color was due to genetics. What started out as a study to find out whether variation in color stability was strictly due to environmental factors resulted in a multi-faceted approach to influence color stability," King says.

Studies involved placing steaks in simulated retail-display conditions and evaluating the two main biochemical mechanisms associated with variation in lean color stability—oxygen consumption (high consumption leads to browning) and metmyoglobin-reducing activity (high levels keep meat red). Metmyoglobin is responsible for the brown coloration that occurs as meat ages.

"We concluded that there were substantial differences across animals in color stability and that there were genetic components that should make it possible to improve stability through genetic selection," King says. "In addition, we developed models using the Vis/NIR technology that would allow companies to identify beef and pork suitable for retail markets that require a long color life."

Research suggests that the multifaceted technology can be used efficiently and cost-effectively to control and manage variation in tenderness and color stability for beef as well as pork, Shackelford says. More research is under way to further evaluate and validate its many applications.—By **Sandra Avant,** ARS.

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STEVEN SHACKELFORD (2589-1)

A visible and near-infrared reflectance (Vis/NIR) spectroscopy probe head is applied to a top sirloin steak to predict tenderness and color stability.

To reach scientists mentioned in this article, contact Sandra Avant, USDA-ARS Information Staff, 5601 Sunnyside Ave., Beltsville, MD 20705-5129; (301) 504-1627, sandra.avant@ars.usda.gov.

STEPHEN AUSMUS (D2590-1)