Improving Meat Tenderness

Dr. John Marchello and Dr. Ron Allen
Outline (for the boring part of the talk)

• Why is meat tender or “less tender” (tough)
• Muscle structure and contraction
• Rigor mortis and meat tenderness
• Post-mortem aging of meat
Fundamental Aspects of Meat Tenderness

• Background Aspects of Tenderness
  – Primarily Connective Tissue
    • Muscle use
    • Age

• Contractile Machinery
  – Degree of contraction
  – Integrity of the contractile machinery
Muscle Structure
Muscle Structure
Muscle Contraction
Rigor Mortis

- Muscle continues to contract and relax after death
- Without oxygen, lactic acid builds up
- Energy production stops
- Muscle filaments permanently lock together
- Muscle becomes stiff
- If filaments lock in a relaxed state, muscle is tender
“Cold Shortening”

- Cold temperature causes contraction
- Filaments lock together in a contracted state
- Rate of chilling and Rate of rigor mortis affect cold shortening
Postmortem Aging

Calcium activated enzymes (Calpains) break filament structure

Breakdown of contractile machinery integrity increases tenderness

Calpastatin, an inhibitor of calpains prevents breakdown and decreases tenderness

Nutrition, management and genetics can affect levels of Calpains and Calpastatins - therefore, tenderness can be altered.
Outline

• Why is meat tender or “less tender” (tough)

• Rigor mortis and meat tenderness – state of contraction determines tenderness

• Post-mortem aging of meat – degradation of contractile machinery by Calpain enzymes results in increased tenderness during aging
How can we control these factors?
METHODS USED TO TENDERIZE MEAT
PALATABILITY

• Of the six meat palatability factors (tenderness, juiciness, flavor, aroma, color, texture), tenderness is generally considered the most important palatability factor by the consumer.

• In recent years, the meat industry has made great progress in improving tenderness both through genetics improvement and meat science technology.
DIFFERENT MUSCLES

Different muscles in the meat animal have different functions.

• Some muscles are defined as muscles of locomotion. These muscles are used to move the animal and as a result of this function, they are less tender.

• The other muscles in the meat animal are called muscles of attachment. They do very little work and as a result of less work they are more tender.

• They are often called middle meats and they sell for a higher price because of their tenderness.

• Muscles found in the loin and rib are examples of muscles of attachment.
Muscles of attachment

Major muscles of locomotion
• After death, the muscle fibers contract as the lactic acid content increases in the muscle.
• This is known as rigor mortis and this occurrence causes muscle to become less tender especially in young cattle.
• Rigor is complete after about 48 hours post-mortem. The lactic acid is produce after death from glucose which is stored in muscle.
• This is called “post-mortem glycolysis” and occurs without oxygen. Rigor causes the muscle to shorten which results in muscle toughening.
• Therefore, the muscle contractile unit called the scarcomere must be broken down to improve tenderness which will allow the heat of cooking to further improve tenderness.
• As a consumer, how do you measure tenderness of a steak?
• Some people determine tenderness by how easily the teeth sink into the piece of steak upon first bite.
• Others determine tenderness based upon the number of chews before the piece is swallowed.
SHEAR FORCE

• From a research standpoint, a number of procedures are available to measure tenderness.
• One of the best procedures is determining the pounds of force required to shear a $\frac{1}{2}$ inch core of the steak.
• The steak is cooked to 160$^\circ$ F and at least 8-$\frac{1}{2}$ inch cores are removed from the steak and a Warner-Bratzler shear machine is used to measure the pounds of force required to shear the core.
A METHOD OF TENDERNESS EVALUATION

Warner- Brazler Shear Force
Cooking to measure tenderness by shear force value
Coring for shear force measurements
• Shear values less than 7 – VERY TENDER
• 7 to 10 – tenderness decreases as shear value increases
• 10 and up -- tough
# SHEAR FORCE VALUES

## WAGULI VS. BRAHMAN

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TENDERIZATION PROCEDURES

- DRY AGING
- WET AGING
- ELECTRICAL STIMULATION
- MECHANICAL TENDERIZATION
- GRINDING
- CHEMICAL
DRY AGING
VACUUM PACKAGING
WET AGING
PROTEOLYTIC ENZYMES

• Cathepsins from lysosomes

• Calpain – two types µ & m

• Macro Ca++ and Micro Ca++

• Calpastatin – depresses Calpain action
# SHEAR FORCE VALUES

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Brahma carcasses possessed 3 times more Calpastatin than the Waguli cattle carcasses
TEXAS TENDER STRETCH
MECHANICAL TENDERIZATION

Blade tenderizing
Stainless steel blades
Penetrating the muscle
BLADE TENDERIZATION
CHEMICAL TENDERIZERS

– Papain extracted from papaya
– Bromelain extracted from pineapple
– Ficin extracted from figs
CHEMICAL TENDERIZERS

• Primal cuts such as the rib or loin care injected with the enzyme

• The steaks are cut from the primal cuts and cooked.
• The heat of cooking will activate these proteolytic compounds to help tenderize during the cooking process.

• These enzymes are activated by heat at about 100° F and deactivated at 140° F.

• There are chemical tenderizers that can be purchased for home use as well.
OVER COOKING MAY CAUSE A DECREASE IN TENDERNESS