TEXTURE and TENDERNESS

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TEXTURE and TENDERNESS

- Most highly rated by the average consumer

Texture

- Texture is the function of size bundles into which the perimyseal connective tissue divides the muscle longitudinally as seen by the eye.
- Divides muscle in fine and coarse grained.
- The size of the bundles is not only determined by the number of the fibers but also by the size

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- Coarseness of texture increases with age but is not apparent in fibers that are small
- In general coarseness is grater in muscles of male animals and those of large frame (breed)
- The amount of perimyseal connective tissue is important in determining coarseness
- There is no direct relationship between coarseness and tenderness.

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Tenderness

- Is the impression of the palate and involves ease of penetration by the teeth, ease with which meat breaks into fragments and amount of residue remaining after chewing

Pre-slaughter factors

- Species is the most general factor but this is a reflection of the texture. Large size like cattle compared to sheep and pigs

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- Age- increasing age denotes decreasing tenderness

Tenderness rating of various beef muscle (Simone et al 1959)

Muscle	18 months	30 months
Adductor	4.67	3.85
Semimembranosus	3.91	3.35
L. dorsi (6-8th rib)	6.21	5.95
L. dorsi (9- 11th rib)	6.16	5.57

High rating denotes greater tenderness

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- Over 40 months of age the difference is very small
- There are differences between muscle in tenderness with Psoas being the most tender and Semimembranosus being tough
- Tenderness within a muscle may vary greatly. Tenderness of beef *Biceps femoris* increases from insertion to origin

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Muscle composition

- Made up of three proteins – myofibrillar (actin, myosin, tropomyosin etc), connective tissue (collagen, elastin and reticulin) and sarcoplasmic proteins
- Only collagen seems to be important in affecting tenderness
- Connective tissue is found in three areas in meat as epimyseal, perimyseal and endomyseal connective tissue

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- Collagen constitutes 2% of total body protein. It is arranged on parallel, stagger overlap with the length of 300nm and 1.5 nm wide.
- Its basic primary structure is made up of 3 AA, glycine, proline and hydroxyproline
- The third residue is always glycine while the other interchange between proline and hydroxyproline

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- Glycine is important at this position as it forms hydrogen bonding with glycine of adjacent fibers to stabilize the molecule (Intramolecular cross links)
- Collagen is helical in shape, with 3 strands wound around one another to form a triple super helix
- The N and C terminals are not involved in helix formation but in intermolecular cross links

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- Chemical analysis shown that there are several distinct tissue specific collagens - based on AA sequence of the triple helical strands(One α_1 and two α_2)
- Five types of α_1 hence Type I-V.
- Type I predominantly found in Peri and epimysium
- Type II in cartilage and interveterbral discs
- Type III in perimysium

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- Type IV in endomysium and Type V in endomysium
- Two types of cross links are found in collagen- heat labile and heat stable ones.
- Meat with higher proportion of collagen with heat labile bonds on heating these are denatured and the meat is tender.
- Meat with a higher proportion collagen with heat stable bonds is tough on cooking because collagen retains some residual tensile strength

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- When cooked, myofibrillar are denatured at 45^{o}C and collagen at 65^{o}C. If collagen is that with heat stable bonds, it contracts, expels water and tight packing of myofibers increasing collagen content per unit area – tough meat.
- Quantity of collagen is also important. Meat with high content of collagen is tough. However, veal though has higher collagen

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- Than meat from mature beef is tender meat. The reason here is the type of collagen . In veal has heat labile bonds , mature beef have heat stable bonds. Heat labile bonds are transformed to heat stable bonds with age.
- Release of soluble protein, hydroxyproline and Ninhydrin positive material from connective tissue of *Biceps femoris* after incubation with collagenase after 12 hrs of incubation (Groll et al 1964)

Age in months	Sol. Protein ug/ml	Hydroxyproline ug./ml	Ninhydrin positive
1.5	230.7	28.8	456
13-16	122.7	11.3	148

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Post slaughter factors

- Extent of shortening PM. As muscle undergoes glycolysis, there is reduction in tenderness. However at ultimate pH, tenderness increases. This is a reflection of WHC
- Cooling. Review cold shortening and thaw rigor how these affect tenderness

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- Conditioning. Meat kept under chill conditions for 14 days . Referred to as ageing, ripening and conditioning.
- If meat is conditioned, increrase in tenderness due to rigor is reversed. This is not because of breakdown of actomyosin bond or collagen. No evidence of increase in soluble hydroxyproline content

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- The answer seems to lie on the loss of muscle structure during this period. Desmin is a protein of the Z disk. It holds the actin filaments in parallel. During conditioning, desmin is extracted out. Equally Troponin T a third component of Troponin complex is lost.
- Enzymatic action during this period have been implicated in the increase in tenderness.

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- CAF, CANP, CASF are names to one enzyme that has been widely studied. This enzyme has been linked with disappearance of Desmin and Troponin
- If it acts on these proteins and loosens the myofibrillar structure leading to increase in tenderness, it must be active at pm period.

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- CAF has optimum activity at pH 7.0 at pH 5.4 the ultimate it retains 15-25% of its activity.
- Since it is calcium dependent, at optimum activity pH 7.0 [Ca^{2+}]is at 1-5mM in the cytoplasm. During pm period, in order to stimulate activity [Ca^{2+}] is at 0.5mM and this can stimulate about 6% of its optimum activity

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- Other enzymes are the Cathepsins B and D. Cathepsin B and D have been found to act on myofibrillar proteins but not collagen
- Cooking. This may either increase or decrease tenderness. Collagen is denatured at 65^{o}C, and turns into gelatin. Myofibrillar coagulate at 45^{o}C. These effects have the effect of increasing the protein per unit area and toughen the meat. This is an effect of temperature and time

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- Long time, low temperatures have effect of making meat tender, good for meat with high connective tissue content
- High temperature, short time cooking toughens meat
- Artificial Tenderization. Not new. Beating, marinating, use of acids (honey).
- Enzymes have been used as dips, injected preslaughter.

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- Use of bacterial and plant enzymes.

Enzyme	Activity against		
	Actomyosin	Collagen	Elastin
Bacterial and fungal			
Protease 15	+++	-	-
Rhozyme	++	-	-
Fungal amylase	+++	Trace	_
Hydralase D	+++	Trace	_
Plant			
Ficin	+++	+++	+++
Papain	++	+	++
Bromelain	Trace	+++	+

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- Purpose
  - Factors affecting tenderness (pre and post slaughter factors)
  - Tenderization process (artificial)

References

- Meat Science by R.A. Lawrie
- Principles of Meat Science by Forrest et al
- The Science of meat and Meat Products Price and Swheiggert