Conversion of muscle to meat
introduction

- Muscle function and meat quality
- Muscles do not suddenly terminate all their living functions and become meat.
- A number physical and chemical change take place over a period of several hours or even days.
- It is a gradual degradative process.
In the living state, all organs and systems within the body cooperate to maintain an internal environment under which each can perform its function efficiently. Only within a narrow range of physiological condition (pH, Temp, O₂, and energy).

Maintenance of the physiologically balance internal environment. = Homeostasis
Homeostasis

- Can be regulated by the nervous system and the endocrine system.
- These two systems serve as communication and starring mechanisms and adjust the function of various organs during periods of stress.
If homeostasis is broken

- Many of the reactions and changes that occurred and affected the development of the quality of meat.
- Also, preslaughter stress or environment (immobilization and exsanguination) may alter postmortem changes due to irregulation in living animal bodies.
Handling pre-slaughter

- Immobilization: make animal unconscious = the first step
- Make blood pressure elevate or excessive nerve stimulation = cause tissue damage.
- Exsanguination = the removal of as much blood as possible. In fact, only about 50% of the total blood volume can be removed from the body.
Exsanguination

- marks the beginning of a series of postmortem changes in the muscle.

- Since blood is an excellent medium for growth of spoilage organisms and excess blood in meat cuts is unappealing to the consumers, a thorough bleeding is an essential beginning to the slaughter process.
What condition will be occurred after bleeding

- The circulatory system will be stopped.
- Oxygen and nutrient and wastes also will be stopped transportation.
- The aerobic pathway through the TCA cycle and the electron transport chain stops function.
Less energy in the form of ATP is produced through the anaerobic pathway.

Lactic acid will remain in muscle tissue and increase in concentration as metabolism proceeds.

Heat can make body temperature increased
Postmortem pH decline

- The lowering of pH in muscle due to the accumulation of lactic acid.
- One of the most significant postmortem changes.
- Approximately pH 7.4 in living muscle
Normal condition:

\( pH \ 7.4 \quad 6-8 \text{ hrs} \quad pH \ 5.6-5.7 \ \text{and the ultimate pH (24 hrs postmortem) of about} \ 5.3-5.7. \)
PSE-pale, soft, exudative

Is an abnormal condition.
The pH will drop rapidly to around 5.4-5.5 during the first hours after bleeding.
Will ultimately develop a pH in the range of 5.3-5.6.
DFD-Dark, Firm, Dry

- The pH drop only a few tenths of a unit during the first hour after slaughter and then remains stable at a relatively high level.
- The ultimate pH in the range of 6.5-6.8


**Resulting Meat Color**

- **Dark**
- **Normal**
- **Pale**

**pH**

<table>
<thead>
<tr>
<th>pH</th>
<th>7.0</th>
<th>6.5</th>
<th>6.0</th>
<th>5.5</th>
<th>5.0</th>
</tr>
</thead>
</table>

**Hours Postmortem**

- 1
- 2
- 3
- 4
- 5
- 6
- 24
Temperature and pH

- Temperature plays a key role in denaturation.
- High temp can make a fast heat of continuous metabolism (glycolysis, lactic acid, pH) and also make the pH of the carcass rapidly decline (5.2-5.4).
Denaturation

- A loss of protein solubility.
- Loss of water
- Loss of protein bonding capacity
- Loss in intensity of muscle pigment coloration.
Rigor Mortis

-One of the most dramatic postmortem change.
-The formation of permanent crossbridges in muscle.
-That forms actomyosin
-Can be relax in living animal but be broken by enzymes in carcass
The onset of rigor mortis

- loss of elasticity
- loss of extensibility, shortening and tension development

The time required for muscle of different animal species to enter the onset of rigor mortis will be showed in Table.
ISOMETRIC TENSION OF MUSCLE

Resolution of Rigor

Rigor Completion

Rigor Onset

TIME POSTMORTEM

TENSION
<table>
<thead>
<tr>
<th>Species</th>
<th>Hours</th>
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<tbody>
<tr>
<td>Beef</td>
<td>6–12</td>
</tr>
<tr>
<td>Lamb</td>
<td>6–12</td>
</tr>
<tr>
<td>Pork</td>
<td>1/4–3</td>
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<tr>
<td>Turkey</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Chicken</td>
<td>&lt; 1/2</td>
</tr>
<tr>
<td>Fish</td>
<td>&lt; 1</td>
</tr>
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</table>
Resolution or softening of rigor mortis

- Alteration in ultra-structure of myofilaments
- Changes in other protein of the cytoskeleton
- Action of neutral protease enzymes
- Relate directly to tenderization in meat aging.
**cathepsins**

- Proteolytic enzymes
- Hold in lysosomes.

*As the pH of the muscle drops (pH < 5.6), these enzymes are released and probably begin to degrade protein structure of the muscle.*
Calpains

- Calcium activated muscle protease
- pH optima at 6.6-6.8
- Are found in sarcoplasm in myofibers
Factors affecting postmortem changes and meat quality

- Meat quality: tenderness, juiciness, color and flavor.
- Processing properties: emulsifying capacity, binding ability, cooking loss, cooked meat color.
- Some ante- or post mortem’s factors will affect above conditions.
Ante mortem

- The new environment or stress – heat or cold
- Are aided by the release of certain hormones – epinephrine and nor-epinephrine – respond
- Sex – odor (boar)
- Diet - fasting 12-24 hrs for animal before slaughter
- Pre-slaughter handling: transportation, loading.
- Stunning: should be followed as quickly as possible by rapid bleeding
Post mortem

- Temperature: chilled quickly as possible
- To minimize protein denaturation
- To inhibit growth of microorganisms
Thaw rigor

- Resulting from low temperature in muscle before onset of rigor mortis
- Is a severe type of rigor mortis that develops when muscle that was frozen pre-rigor is thawed.
- By sudden release of Ca+2 into the sarcoplasm and cause a physical shortening of 60-80% of original length
- Meat quality-dry and severe toughening
Figure 5.8. Thaw rigor shortening. A freshly excised muscle sample (bottom) is shown in comparison with an identical sample that was frozen prerigor and thawed (top). The sample that has undergone thaw rigor (top) is only 42 percent of its original length.
Cold shortening

- Resulting from low temperature in muscle before onset of rigor mortis.
- Chilled temperature above 0°C but below 15-16°C.
- Shortening is less severe than that of thaw rigor.
- The problem may become more serious as efforts are made to produce animals with less fat—Beef and Lamb.
Heat rigor

- Severe shortening may be induced by maintaining muscle at relatively high temperature (up to 50°C).
- Is the result of a rapid depletion of ATP stores.
Electrical stimulation (ES)

- Used to improve tenderness and meat quality in turkey, lamb, beef and veal.
- Is acceleration of rate of postmortem pH decline.
- Is hastening of rigor mortis
Meat tenderization by ES

- Cold shortening prevention through acceleration of glycolysis and rigor onset.
- Proteolytic enzymes activation through acidification at high temperatures
- Physical disruption of fiber structure through extreme muscle contraction
- Varies from 30-3600 volts
Figure 5.15. Beef carcass electrical stimulation.
The end of this chapter

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