Post Mortem muscle chemistry-2
Rigor Mortis and Aging of meat

A Gateway to All Post Graduate Courses

Contents:

1. Theories of Rigor Mortis
2. Phases of rigor mortis
    - 2.1 Delay phase
    - 2.2 Onset phase
    - 2.3 Completion
3. Ripening of meat
4. Changes in color of meat
5. Loss of immunity
6. Loss of structure integrity
7. Post mortem issues
    - 7.1 Thawing rigor
    - 7.2 Cold shortening
    - 7.3 Heat Ring
    - 7.4 Blood splash:

Introduction:

- Rigor mortis is also called "death stiffening".
- It is stiffening of muscle and is also an important post mortem change.
- It is known that a particular level of ATP complexed with Mg^{++} is required for breaking the actomyosin bond and bringing the muscle to relaxed state and it drops permanent actomyosin cross bridges begin to form and muscle gradually become less and less extensible under an extremely applied force.
- Rigor mortis is important in meat products since muscle cooked while still in rigor are are much tougher then if it is allowed to pass before cooking

Theories of Rigor Mortis

- Bate and Smith proposed the theory of rigor mortisthat include reaction of protein of muscle and change in them. They believe that disappearance of adenosine triphosphate (ATP) is of great importance in development of muscle stiffening of rigor mortis.

- Szent and Gyorgyi point out that creatine phosphate recently has been shown essential for relaxation of contracted muscle, and he believes its appearance may be of prime importance in stiffening of rigor mortis.

Phases of Rigor Mortis development

Rigor mortis occurs in 3 phases, the extent and contraction of muscle contraction is as shown in figure1. The 3 phases of rigor mortis development are :

1. Delay phase

2. Onset phase:

3. Completion:

A Gateway to All Post Graduate Courses

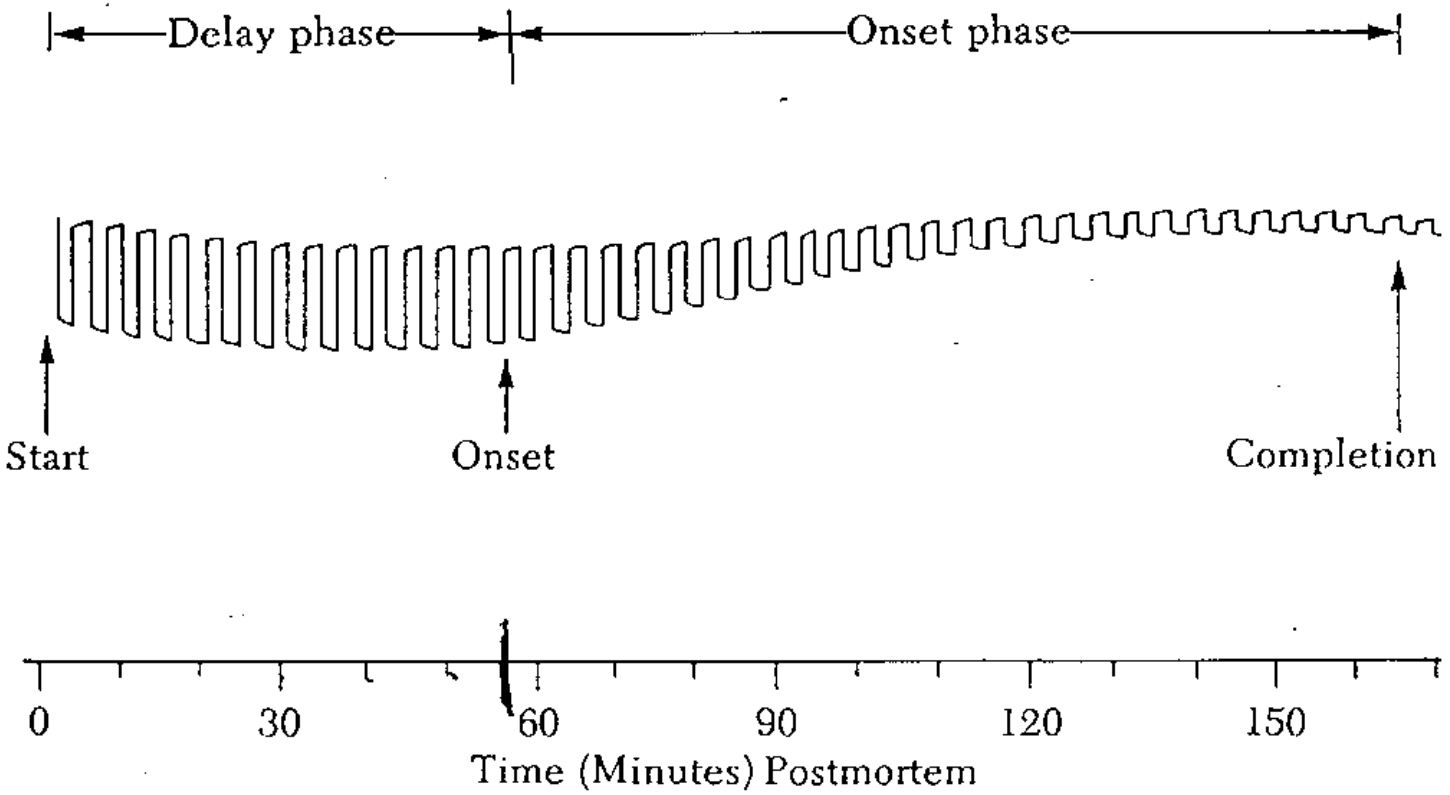
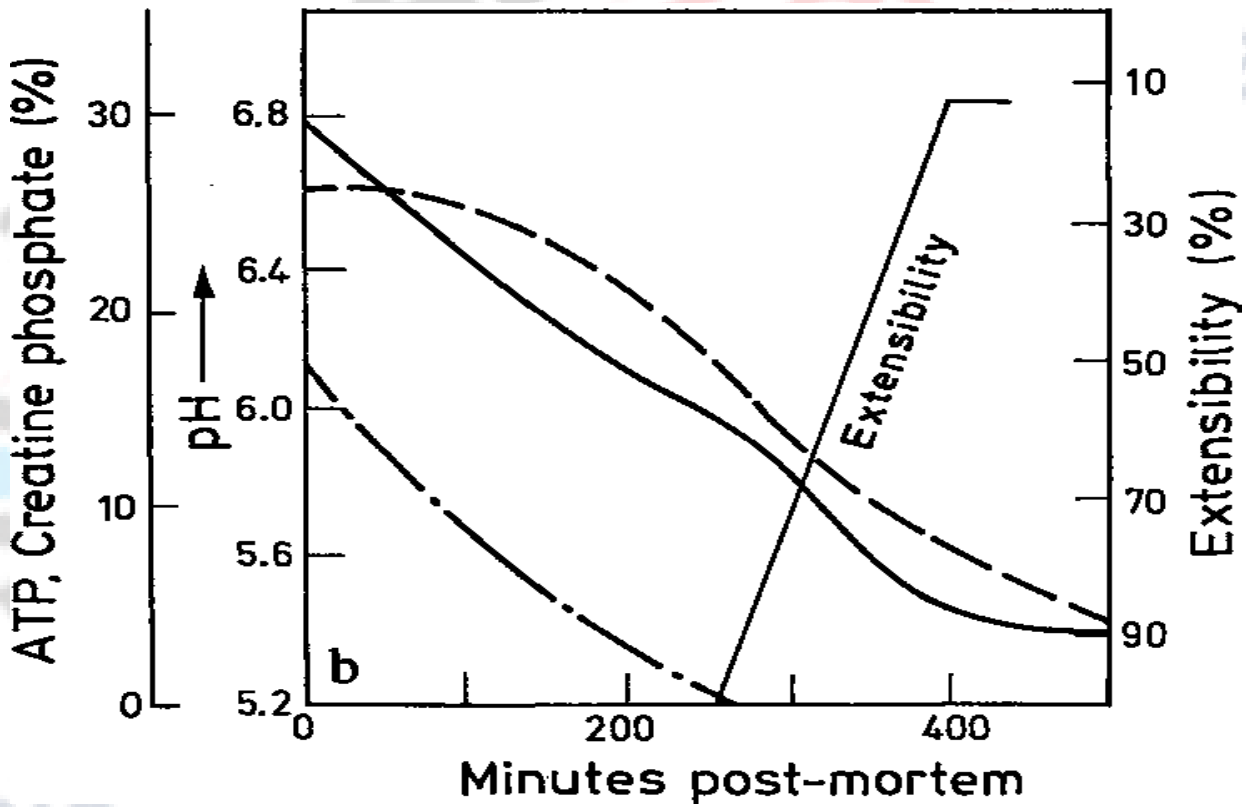


Figure1. Extensibility of muscle during rigor development and stages of rigor mortis.

Ripening of Meat

- After the passing of rigor mortis, meat become more tender and jucier and flavorful. Rigor mortis in muscle tissue is usually resolved 2–3 days post mortem. By this time, the meat again becomes soft and tender (in case of beef especially). Further aging of the meat to improve tenderness and to form aroma requires various amounts of time, depending on the temperature.
- At temperatures around 3 ◦C (−1 ◦C to +7 ◦C), aging of poultry requires at least 36 h, pork 60 h, veal 7 days and beef 14 days.


ATP, Creatine phosphate (%)
30
20
10
0
pH
6.8
6.4
6.0
5.6
5.2
b
Extensibility
10
30
50
70
90
Extensibility (%)
0
200
400
Minutes post-mortem

Changes in color of Meat

- Main pigment of muscle is myoglobin, a red colored conjugated protein, which is not completely bled during exsanguinations.
- Most of the blood cells remain in numerous blood vessels and traverses the muscle tissue, which contains hemoglobin. Other things, like some colored enzymes like heme pigments also occur in muscle.
- They are cytochromes and peroxidase.
- The molecular weight of myoglobin is one fourth of hemoglobin, likewise show difference in amino acid composition and solubility

Loss of immunity:

During post mortem period, body defense mechanism stops operating and membrane proteins alter the properties of meat membrane, which lead to the invasion of microorganism. However, low pH cause some defense against the invading microorganism. Handling and precautions during meat slaughtering can resist invasion of organism to some extent.

Loss of structure integrity:

- Post-mortem alteration of membrane properties initiates the degradation of muscle proteins and cause progressive disruption of myofibrillar structure. Enzymes like cathepsin which remains inactive in living tissue become active as muscle pH drops.
- These initiates the degradation of muscle protein and thus loose the structure integrity. Calpains (Calcium-activated Proteins) degrades proteins during cooler aging. Calpastatins inhibit the action of calpains (Brahman cattle contain higher levels).
- Thus, if an animal has a higher calpastatin level, the calpains are less active, and cooler aging has less affect on muscle tenderness. Brahman cattle are naturally tougher because of higher contents of calpastatin

Post mortem issue:

1. **Thawing rigor**
2. **Cold shortening**
3. **Heat Ring**
4. **Blood splash**

A Gateway to All Post Graduate Courses

1. Thawing rigor: Muscle is frozen before rigor mortis occurs because, ATP hasn't been used in rigor mortis events and is high when the muscle is frozen and When thawing occurs, calcium is released from the Sarcoplasmic Reticulum, causing a massive contraction because of the high ATP level. It results toughening of mass.

2. Cold shortening: Similar events occur when cold muscle shortens except it isn't frozen (chilled below 15°C – 16°C onset of rigor mortis occurs). Because of too quick chilling, the SR is unable to hold the calcium. Muscle contraction occurs while ATP still is available. Electrical stimulation helps prevent cold shortening by using up the ATP in contractions.

3. Heat Ring: It is found in carcasses with a thin rind i.e. lean carcass which are not chilled properly. Outer ring of muscle gets cold too quickly because of slower glycolytic rate and slower pH decline, this Result is an undesirable ring around the muscle that is darker in color, coarser in texture.

4. Blood splash: Blood splash is caused by rupture of capillaries, usually between stunning and sticking times. This occurs due to blood pressure increases after stunning and results in small blood spots in muscles. This problem mostly occurs in hogs and poultry. An excessive stun:stick interval can cause blood splashing as can excitement before stunning.

References

1. Bate-Smith, E.C., "Physiology and chemistry of rigor Mortis," Advances in Food Research, 1, 1-34 (1948).
2. Crocker, E.C., " Flavor of Meat," Food research, 21,122-132 (1956).
3. Urbain, W.M., " Meat and meat products'" in Jacobs, M.B., ed., " Chemistry and technology of food and food products,' Interscience publication., Inc., New York, N.Y., 1951.
4. Whitaker, J.R., "Chemical Changes associated with ageing of meat with emphasis on the protein,' Advances in Food research, 9 (1959).
5. Wierbicki, E.., Kunkle , L. E., cahill, V.R. and deatherage, F.E., " The relation of tenderness to protein alteration during postmortem aging," Food techno.,8,506-511 (1954) 10:80-86 (1956).