

CONVERSION OF MUSCLE TO MEAT

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INTRODUCTION

- Meat is the post-rigor aspect of muscle and the conversion of ‘Muscle to Meat’ is the result of series of biochemical changes initiated in muscle at the death of animal due to stoppage of the blood circulation.
- Exsanguination leads to immediate loss of oxygen supply to the muscle, decreasing oxidation reduction potential, resulting in cytochrome system, thus ETC and TCA cycle inhibition.
- Depletion of creatinine phosphate soon follows.

- Hence ATP re-phosphorylation aerobically ceases.
- Hence anaerobic glycolysis commences, lactic acid accumulation follows. Decline in pH follows.
- Resynthesis of ATP anaerobically inadequate to prevent actin-myosin formation.
- Onset of rigor.

CHANGES TAKE PLACE DURING POST-MORTEM

- Loss of homeostasis
- Post-mortem glycolysis and pH decline
- Rigor mortis
- Loss of protection from invading Microorganism
- Degradation due to proteolytic enzyme
- Loss of structural integrity
- Thus the conversion of muscle to meat is a series of the above biochemical changes ultimately culminating in the resolution of rigor mortis.

LOSS OF HOMEOSTASIS

- Homeostasis mechanism, a system for physiologically balanced internal environment which helps the body to cope up with the stresses of oxygen deficiency, extreme variation in temperature, energy supply, etc., is lost.
- The homeostasis is controlled by nervous system, which ceases to function within 4-6 minutes after bleeding.
- In the absence of blood supply, there is loss of body heat and temperature starts declining.

POST MORTEM GLYCOLYSIS AND PH DECLINE

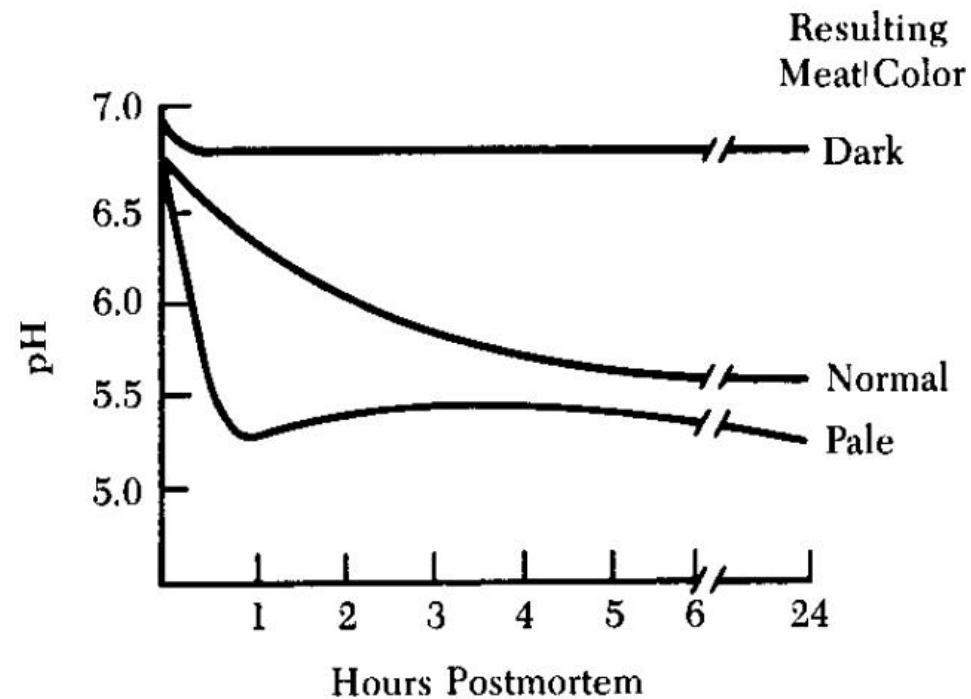
- In the absence of oxygen, anaerobic glycolysis leads to the formation of lactic acid from the glycogen reserves:



- The accumulation of lactic acid lowers down the muscle pH.
- The rate and extent of pH decline are variable, being influenced by the species of food animal, various pre slaughter factor, environmental temperature, etc.

- In most species, a gradual decline continues from approximately pH 7 in the living muscle during first few hours (5-6 hours) and then there is a little drop in the next 15-20 hours, giving an ultimate pH in the range of 5.5-5.7.
- The rate of pH decline is enhanced at high environmental temperature.
- A low ultimate pH is desired to have a check on the proliferating microorganism during storage.

Rate of pH Decline Affects Muscle Properties



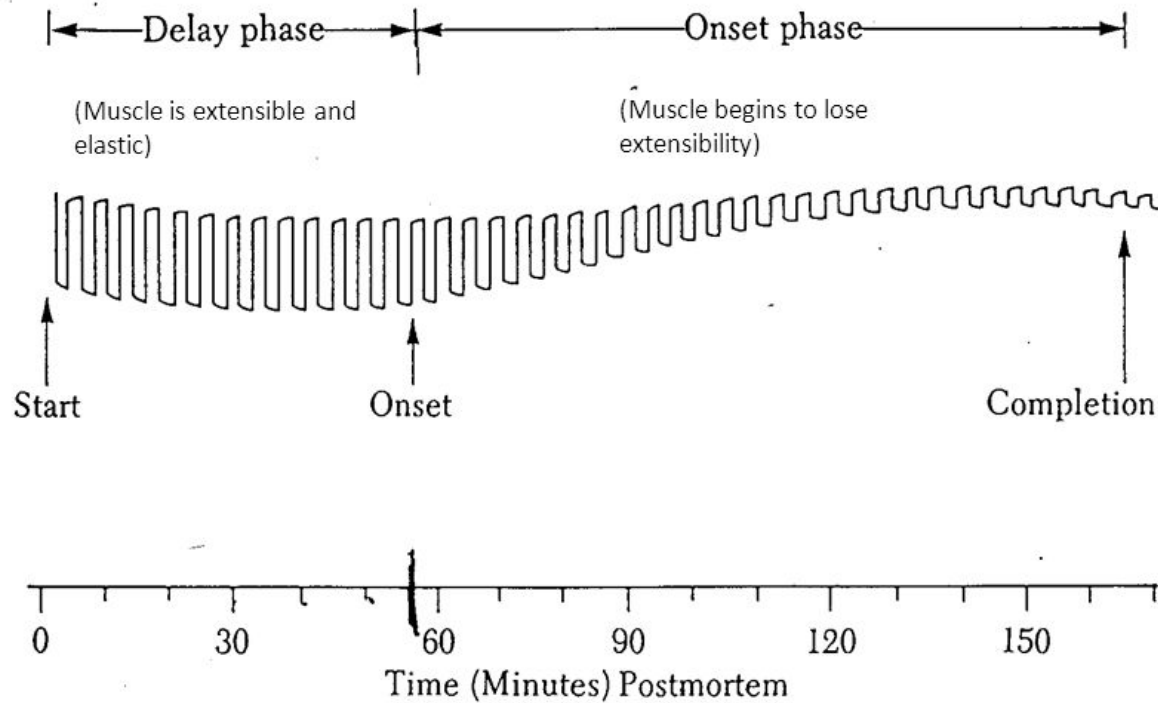
Source: <https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.slideserve.com%2Fliuz%2Fconversion-of-muscle-to-meat>.

RIGOR MORTIS

- It refers to stiffening of muscles after death and is another important postmortem change in the process of conversion of muscle to meat.
- It is now very well-known that a particular level or concentration of ATP complexed with Mg^{++} is required for breaking the actomyosin bond and bringing the muscle to a relaxed state and as it drops, permanent actomyosin cross bridges begin to form and muscle gradually becomes less and less extensible under an externally applied force.
- During the period immediately following exsanguination, the actomyosin formation proceeds very slowly at first and the muscle is relatively extensible and elastic. This period is called the delay phase of rigor mortis.

- Then actomyosin formation picks up and the muscle begins to lose extensibility. This phase is called the fast or onset phase of rigor mortis. When all the creatine phosphate (CP) is depleted, ADP can no longer be phosphorylated to ATP, muscle becomes quite inextensible and stiff.
- This stage marks the completion of rigor mortis is rapid. When postmortem pH decline is very slow or very fast, the onset and completion of rigor mortis is rapid. The onset of rigor mortis is enhanced at ambient temperature above 20°C.
- The phenomenon of rigor mortis resembles that of muscle contraction in a living animal muscle except that rigor mortis is irreversible under normal conditions.

Extensibility of Muscle During Rigor Development



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layer.com%2Fslide%2F)



Source: <https://www.google.com/url?sa=i&url=https%3A%2F%2Fquizlet.com%2F390846862%2Fchapter-11-death-flash-cards>

Time to the Onset of Rigor

<i>Species</i>	<i>Hours</i>
Beef	6–12
Lamb	6–12
Pork	1/4–3
Turkey	< 1
Chicken	< 1/2
Fish	< 1

Source: <https://www.google.com/url?sa=i&url=https%3A%2F%2Fslideplayer.com%2Fslide%2F3471198%2F&psig>

LOSS OF PROTECTION FROM INVADING MICROORGANISM

- During postmortem period, body defense mechanism stops operating and membrane properties are altered.
- So, during conversion to meat, muscle is quite susceptible to invading microorganisms.
- Except for low pH, most of the other postmortem changes favor bacterial growth.
- Hence, utmost handling precautions are necessary to prevent contamination of meat.

DISINTEGRATION OF STRUCTURE DUE TO PROTEOLYTIC ENZYME

- Several autolytic lysosomal enzymes called cathepsins, which remain inactive in a living muscle tissue, are activated as the muscle pH declines.
- These enzymes initiate the disintegration of muscle protein structure into smaller peptides and amino acids.
- In fact, catheptic enzymes are capable of breaking down even collagenous connective tissue of the muscle and cause tenderization of meat during aging.

LOSS OF STRUCTURAL INTEGRITY

- Postmortem alteration of membrane properties initiates the degradation of muscular proteins.
- There is a progressive disruption of myofibrillar structure.
- The resolution of rigor mortis is reported to occur due to disintegration of Z-line structure.
- A rapid decline in muscle pH also causes denaturation of collagenous connective tissue.

CONVERSION OF MUSCLE TO MEAT

- Conversion of 'Muscle to Meat' : Sequence of biochemical changes
- Disruption of homeostasis results in decrease in body temperature.
- Decrease in oxidation reduction potential shifts glycolysis to anaerobic glycolysis, resulting in accumulation of lactic acid and inadequate replenishment of ATP leads to irreversible actomyosin bond formation, increase in muscle tension.
- Decrease in ATP also result in disruption of structural integrity of proteins.
- The decrease in pH ensures that cathepsins become active and thus sarcoplasmic proteins denature.

- Reduction in ATP, formation of actomyosin, approaching of the muscle pH to isoelectric points of myofibrillar proteins and denaturation of proteins, lead to WHC.
- Resolution of rigor is the decrease in muscle tension due to proteolytic degradation of specific myofibrillar proteins that lead to dissolution of Z discs, loss of ultra structural integrity.
- Muscle, post the resolution of rigor is referred to as meat.

THANK YOU

- Reference: Sharma, B.D. (2003). Modern abattoir practices and animal byproducts technology, First edition. Jaypee publisher.