

Understanding the Rigor Mortis in Meat Animals

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What is rigor mortis?

As the term indicates, Rigor means stiffening or hardening, mortis means death i.e. the stiffening of muscles and loss of extensibility or elasticity of muscles after death of animals is called as Rigor Mortis.

What is the reason of Rigor Mortis?

Just immediately after death of animal, the energy metabolism stops the meat is soft and pliable but slowly slowly as time passes ATP declines to zero and pH drops as a result of lactic acid production during anaerobic respiration, which denatures the proteins and as a result make it more permeable for calcium ions, the actomyosin complex and Tropomyosin complexes are forms which are responsible for stiffening of meat.

What are the theories of Rigor Mortis?

Two theories are given for Rigor Mortis given below

1. **By Bate and Smith:** Bate and smith believed that the changes in muscle protein take place as a result of disappearance of ATP which ultimately causes stiffening of muscles.
2. **By Szent Gyorgyi:** Szent and Gyorgyi believed that creatine phosphate is essential for relaxation of contracted muscles and appearance of creatine phosphate plays important role in stiffening of meat.

What are the Phases of Rigor Mortis?

Rigor mortis takes place in 3 phases as given below

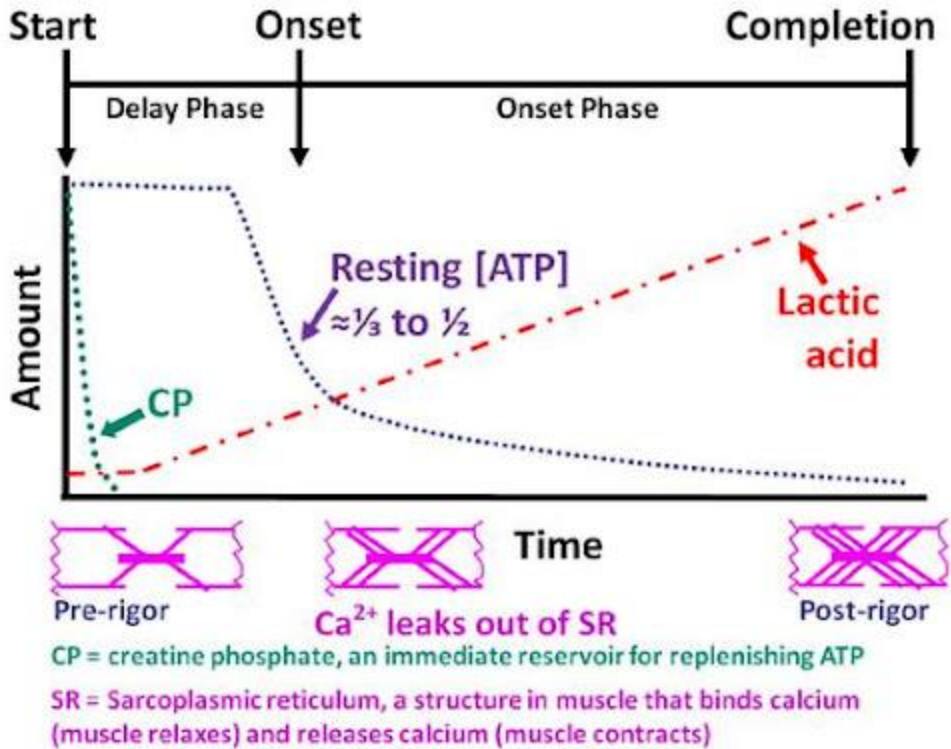
1. **Delay phase**
 2. **Onset Phase**
 3. **Completion**
1. **Delayed Phase:** During the delayed phase, ATP levels are relatively constant, and the muscle is soft, elastic, and extendable. Creatine phosphate (CP) is an important part of this process because it is necessary for the conversion of Adenosine Diphosphate (ADP)

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to ATP for muscle contraction when no oxygen is present. Muscle will remain in the delayed phase if CP is available to maintain the ATP levels, even without oxygen.



2. Onset Phase:

Shortly after CP levels are depleted, the ATP levels will begin to decrease, moving rigor development into the onset phase. During the onset phase, muscle becomes inelastic and unextendible. ATP levels are decreasing, allowing Ca²⁺ release, which in turn allows actin and myosin to form the actomyosin cross-bridges. This continues until depletion of muscle ATP below 1 $\mu\text{m/g}$, when the actomyosin cross-bridges become permanent, because ATP is required to break these bridges. At this point, the muscle is in the final phase of rigor mortis completion.

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muscles because red muscles have a weak sarcoplasmic reticulum. Cold shortening may occur when the muscle is chilled to $< 7^{\circ}\text{C}$ ($<45^{\circ}\text{F}$) before rigor is complete, and the muscle pH is above 6.30. Cold shortening is normally not a problem in pork, because of the rapid post-mortem pH decline. Rigor mortis is typically set when pH is less than 6.00 and before a low muscle temperature can be attained. The exception may be pork that is hot boned, which allows for faster chilling of the muscle.

2. **Thaw rigor:** Thaw rigor occurs when pre-rigor meat is cut and frozen. Once these unrestrained muscles are thawed, the residual ATP and Ca^{2+} cause contraction of the muscle and shortening of the muscle up to 60% (beef, lamb). This contraction results in high moisture loss and severe toughening of the muscle. As with cold shortening, thaw rigor is rare in pork, because rigor is normally completed before the muscles are dissected from the carcass and frozen. If it does occur in pork, the degree of shortening is much less than 60%, as the skeletal structure typically restrains the muscles.