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Rigor mortis and post-mortem changes in fish

- Fish is an extremely perishable food.
- As soon as a fish dies, spoilage begins.
- Spoilage of fresh fish is a rather complex process and is caused by a number of inter-related systems, some of which are suppressed by others.

- In tropics, fish spoil within 12-20 hrs depending on species, method of capture etc
- Species
- Method of capture
- Fishes from cold waters would spoil in lesser than 2 days if stored at 20°C, in low temp of 5°C, can be acceptable for 5-6 days.

- The factors which principally contribute to the spoilage are the degradation of protein with a subsequent formation of various products like hypoxanthine, trimethylamine, development of oxidative rancidity and the action of microorganisms.

Rigor mortis or death stiffening

- Rigor / rigor mortis means the stiffening of the muscles of an animal shortly after death.
- Immediately after death the muscles of an animal are soft and limp, and can easily be flexed; at this time the flesh is said to be in the pre-rigor condition, and it is possible to make the muscles contract by stimulation.
- Eventually the muscles begin to stiffen and harden, and the animal is then said to be in rigor. The muscles will no longer contract when stimulated, and they never regain this property.

- After some hours or days the muscles gradually begin to soften and become limp again.
- The animal has now passed through rigor, and the muscle is in the post-rigor condition.
- Sometimes rigor is said to be resolved; this is simply another way of saying that the muscle has passed through rigor to the post-rigor stage.

- Rigor in fish usually starts at the tail, and the muscles harden gradually along the body towards the head until the whole fish is quite stiff.
- The fish remains rigid for a period which can vary from an hour or so to three days, depending on a number of factors, and then the muscles soften again.

Sensory changes

Post-mortem changes

FRESH

Catch-bleeding-gutting

Blood circulation stops

Glycogen

Lactic acid

ATP falls

pH falls

Rigor mortis

Enzymes activated

AUTOLYSIS



FLAT

Resolution of rigor and autolysis

Microbial spoilage

SWEET/STALE

Microorganisms



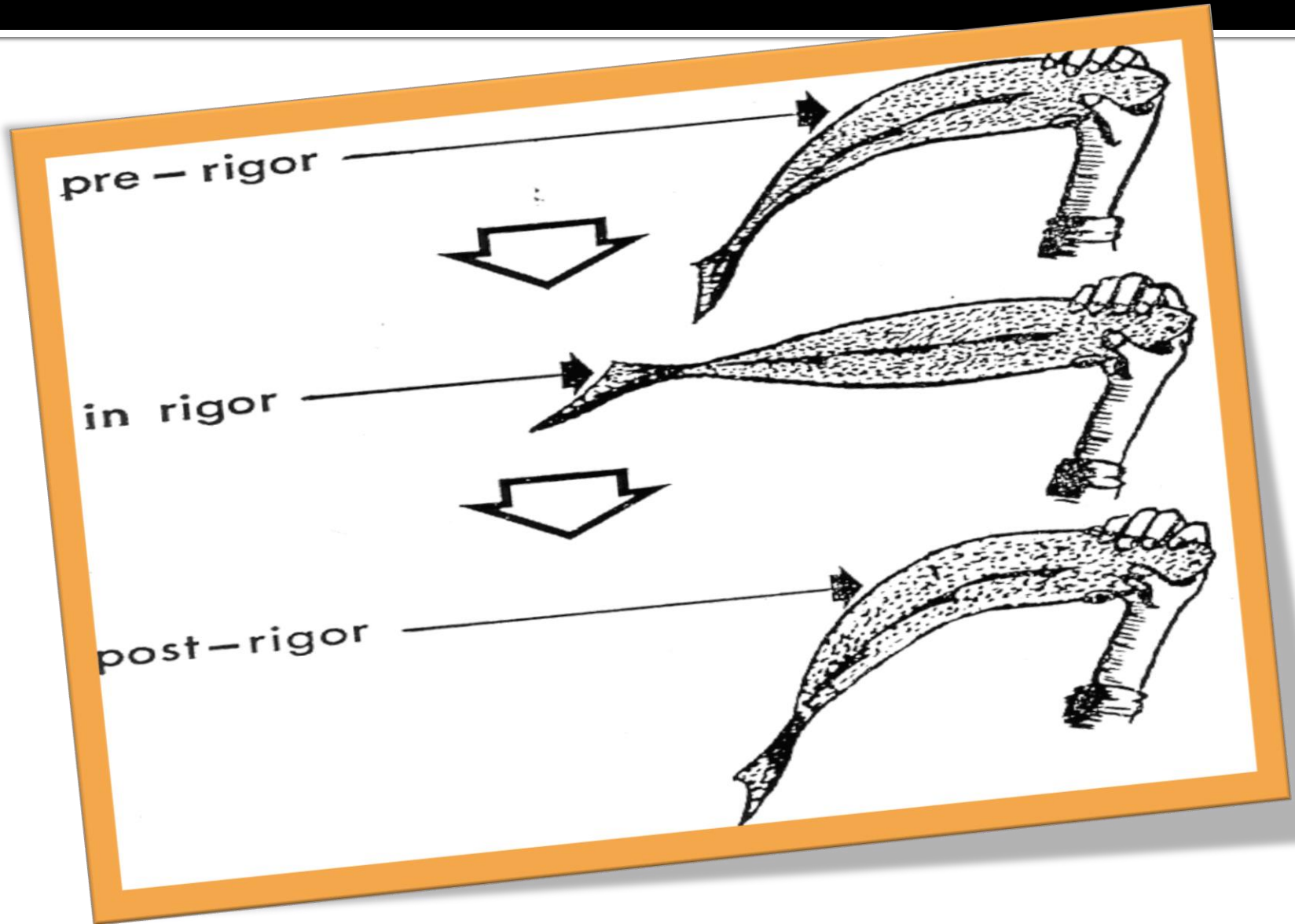
PUTRID

Spoilage

Lipid oxidation



General effect of rigor



How long does a fish stay in rigor?

The time a fish takes to go into, and pass through, rigor depends on the following factors:

- the species
- its physical condition
- the degree of exhaustion before death
- its size
- the amount of handling during rigor and the temperature at which it is kept.

Species:

- Some species take longer than others to go into rigor, because of differences in their chemical composition.

Condition:

- The poorer the physical condition of a fish, that is the less well nourished it is before capture, the shorter will be the time it takes to go into rigor; this is because there is very little reserve of energy in the muscle to keep it pliable. Fish that are spent after spawning are an example.

Degree of exhaustion:

- In the same way, fish that have struggled in the net for a long time before they are hauled aboard and gutted will have much less reserve of energy than those that entered the net just before hauling, and thus will go into rigor more quickly.

Size:

- Small fish usually go into rigor faster than large fish of the same species.

Handling:

- Manipulation of pre-rigor fish does not appear to affect the time of onset of rigor, but manipulation, or flexing, of the fish while in rigor can shorten the time they remain stiff.

Temperature:

- This is perhaps the most important factor governing the time a fish takes to go into, and pass through rigor because the temperature at which the fish is kept can be controlled.
- The warmer the fish, the sooner it will go into rigor and pass through rigor.
- For example, gutted cod kept at 32-35°F may take about 60 hours to pass through rigor, whereas the same fish kept at 87°F may take less than 2 hours.

- Small fish with low reserves of energy, that is exhausted and in poor condition, and kept at a high temperature will enter and pass through rigor very quickly.
- On the other hand, large, rested, well-fed fish kept at a low temperature will take a very long time to enter and pass through rigor.

Rigor changes occurring in fish before it is frozen may affect the quality in three main ways:

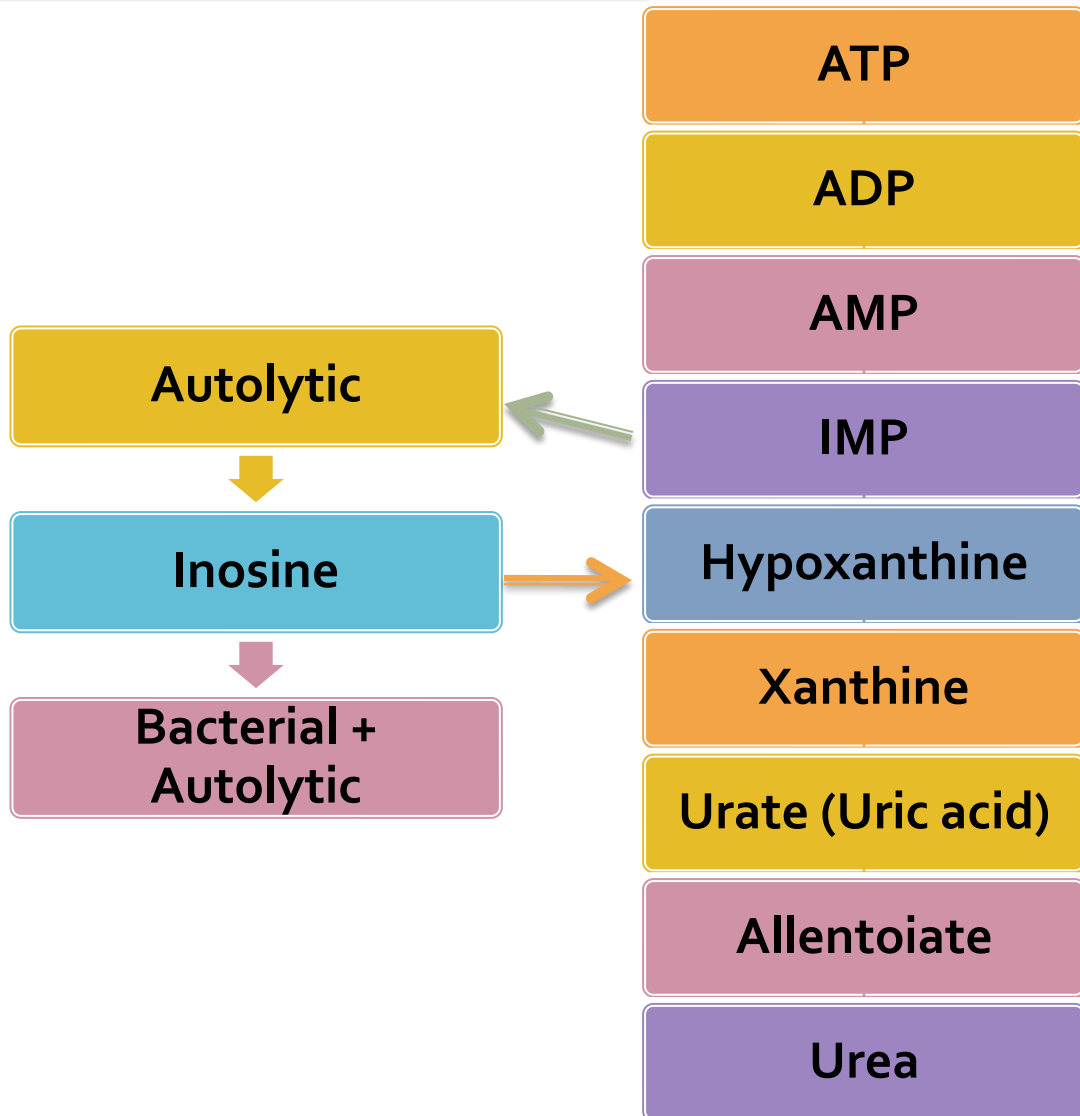
- Toughness and high drip loss in frozen whole fish or fillets;
- Gaping in fillets taken from frozen whole fish
- Shrinkage of frozen fillets.

These undesirable effects can be reduced or prevented by:

- keeping the fish cool, particularly before it goes into rigor;
 - handling it carefully when in rigor;
 - freezing fillets taken from pre-rigor fish as soon as they are cut.
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- Careful treatment of the fish before and during rigor will result in a higher quality frozen product with a correspondingly better market value.

- ATP , which is an energy donor in metabolic processes, is formed in the live fish by reaction between ADP and Creatine Phosphate.
- Creatine Phosphate is the reservoir of energy in the muscle cell.
- On death, this reaction stops and consequently the production of ATP. Stiffness starts when ATP level lowers to 5% of the original.
- Anaerobic glycolysis occurs after death, leading to the production of lactic acid. Lactic acid – acidic pH

Breakdown of ATP in post-mortem changes



- IMP – Distinct taste and flavour of fish
- Hypoxanthine – Bitterness and off-flavour
- Index of freshness and K value based on this

Summary
