**Super freezing of fish: A potential for Long-term and High Quality Storage**

The long-term storage of frozen fish below traditionally accepted temperatures (between -24 and -18 °C) was investigated. The quality of fish strongly depends on reaction rate and physical state of the fish’ tissues. The study investigated the thermal transitions in fish tissues (Rainbow Trout, Atlantic Salmon, Cod; Herring and Mackerel). The precise knowledge of the physical state gives opportunity to find the region of a highest stability for any type of fish.

**Key temperature ranges**

- **from -1 to -33 °C**
  - Ice formation

- **from -33 to -70 °C**
  - Stagnation of quality
  - Positive influence of temperature is negligible

- **from -70 to -85 °C**
  - Glass transition of muscles
  - The muscles are solid and brittle. All unfreezeable water is immobilized. The viscosity of the system is very high, the molecular mobility if very low. This is the highest level of the stability of a quality.

**Outcome of the study:**

Storage below -86 °C. The highest stability of the quality. The highest running costs. Preferable only for exclusive types of fish like tuna. At the same time lipid oxidation may happens, because part of the lipids are still unfrozen.

- Storage slightly below -33
- Increases the high quality shelf-life due to significant decreasing of liquid water content
- Viscosity of the system is high enough to decrease rates of the deteriorative reactions
- The packaging material with barrier properties is required for long-term storage of fatty fish.

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