



Influence of stable and abusive temperatures on lipid deterioration of Atlantic herring (*Clupea harengus*) light and dark muscle during long-term frozen storage

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Background



- **Frozen storage** is the main long term preservation method for fish product
- **The temperature** for frozen fish is at least **-18 °C** (requirement) and **-24°C** (recommend)
- **Unstable storage conditions** are commonly encountered during storage and transportation of frozen fish
- **Temperature abuse** affects the amount of unfrozen water in the muscle enzymatic reactions and lipid oxidation can thus still take place during frozen storage

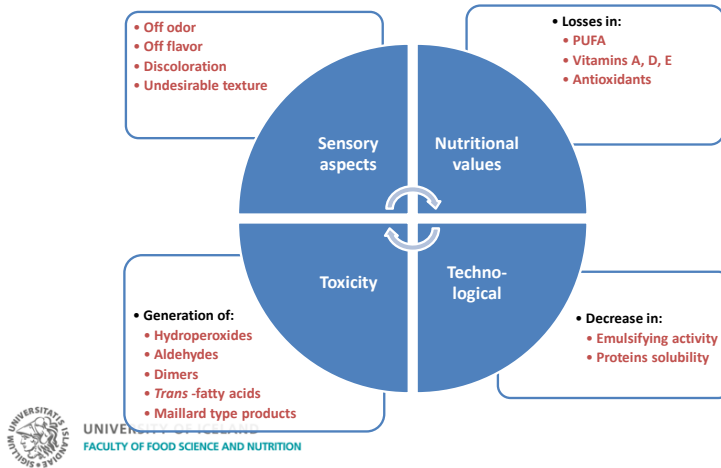


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Background



- Main quality changes of the fish product occurs due to **lipid deterioration**



Background



Atlantic herrings
(*Clupea harengus*)



- An oily fish, a **good source of polyunsaturated omega-3 fatty acids** (PUFA)
- Caught mainly from **October to January** (in Iceland)
- Total catch of **103 thousand tonnes in 2015** (Statistics Iceland, 2016).
- Herring products: **fish meal, fish oil, frozen and salted**
- **Strong limiting factor** in the processing: Lipid deterioration



Factors affecting lipid deterioration development during frozen storage

- Lipid content
- The degree of unsaturated fatty acids
- Fish processing of raw material
- Freezing methods
- **Frozen storage time**
- **Frozen storage temperature**



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Objective

Study the influence of stable and abusive temperatures on lipid deterioration of Atlantic herring (*Clupea harengus*) light and dark muscle during long-term frozen storage



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Experimental setup



Raw material (commercial frozen block)

Stored at an abusive temperature (-12 °C) for one month, followed by stable storage at -25 °C for up to 11 months

Stored at a stable temperature of -25 °C for up to 12 months

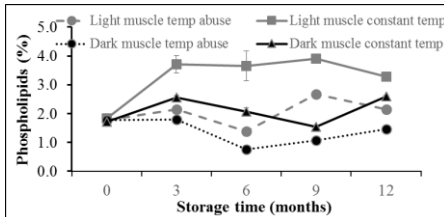
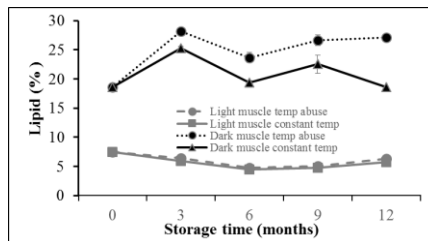
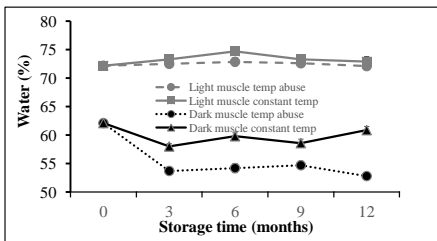
0, 3, 6, 9, 12 months

Water content/ Lipid content/ Phospholipids content
Fatty acid composition
Lipid oxidation (PV,TBARS)/ Enzyme activity (FFA)



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The effect of storage temperature on chemical composition



Temp abuse affected water content and lipid content of the dark muscle

Temp abuse affected phospholipids content of both type of muscle (light and dark)



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Fatty acid composition



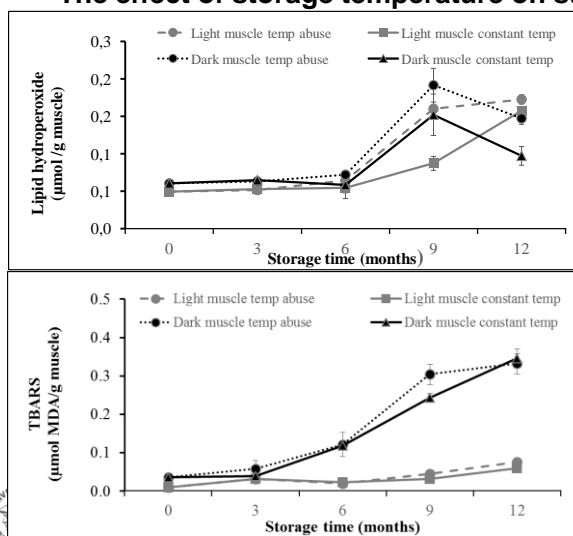
- The light muscle had a significantly higher amount of DHA and EPA compared to the dark muscle in all samples stored at both storage conditions
- Atlantic herring (caught in Icelandic water) had a high nutritional value with regards to the MUFA and PUFA values, and is a good source of DHA



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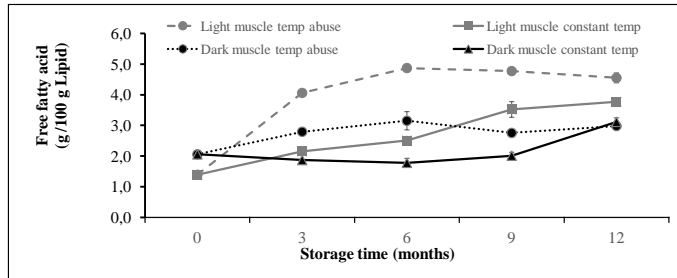
The effect of storage temperature on stability of lipids



- A more progressive lipid oxidation in the dark muscle during storage.
- TBARS increased significantly through the storage time



The effect of storage temperature on stability of lipids



Higher hydrolytic activity ($p < 0.05$) was observed in the light muscle

FFA content in the samples stored at the constant temperature was significantly lower than samples stored at abusive condition.



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Summary

- Temperature abuse effect: increased lipid oxidation and lipid hydrolysis of both muscle types.
- The dark muscle was more sensitive towards lipid oxidation than the light muscle
- The light muscle was more sensitive towards enzyme activities than the dark muscle
- Fatty acid composition analysis indicated that the light muscle is a good source of omega-3 and has a higher nutritional value compared to the dark muscle.

Avoid temperature fluctuations during frozen storage to improve the quality and shelf-life of frozen herring products.

Removal of the dark muscle by deep-skinning could be beneficial towards increased shelf-life of the more valuable light muscle



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Thank you for your attention!



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