Injection of Fish Protein Solutions to Fresh Saithe (*Pollachius virens*) Fillets Studied by Low Field NMR and Physicochemical Measurements

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Introduction

Low field Nuclear Magnetic Resonance (LF-NMR) transverse relaxation time (T2) measurements were used in comparison to yield and physicochemical measurements to assess the effects of salt and protein injection on the properties of saithe fillets during chilled and frozen storage. Six injection solutions with combinations of salt, homogenized fish proteins (HFP), gelatine and fish protein hydrolyzate (FPHyd) were compared to the properties of untreated fillets after chilled (4 days) and frozen (1 week and 1 month) storage.

Materials and Methods

Low field NMR measurements were performed on a Bruker mq 20 benchtop instrument with a performing freqency of 20 MHz. Minced samples from the middle part of the fillet were placed in 10 mm tubes and measured at ambient temperature. Transversal relaxation times were measured using the CPMG pulse sequence with a τ of 250 µs, N=8100, RD=10s, NS=16 scans and a receiver gain of 70 dB.

Results

Yield results

- Fillets gained 5-15% weight during injection of salt and proteins
- Injection of the commercial FPHyd resulted in the most stable yield during chilled and frozen storage, indicating that protein injection can be used to stabilize the properties of saithe fillets.
- Addition of gelatine, alone or in combination with HFP(a) had no additional effects on the weight gain compared to fillets only injected with salt or HFP(a) respectively.

Physicochemical results

- The raw material had a moisture content of 81.5±1.2%, protein content of 18.5±0.4% and a salt content of 0.2±0.1% prior to processing.
- Salt and protein addition resulted in higher moisture content than in the control group (83.3-85.4%) in correlation with the moisture content of the injected solutions (R2=0.816, n=6, p<0.05). However moisture was lost during frozen storage in all groups, except the FPHyd injected group (Figure 1).

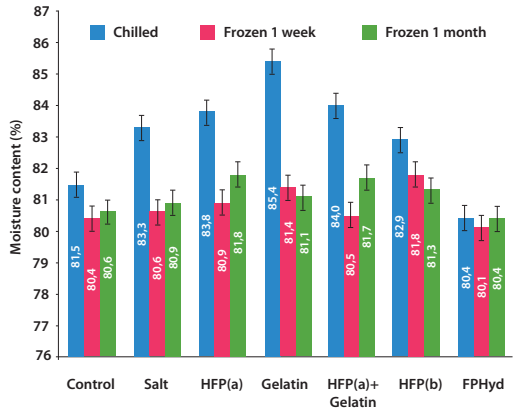

Figure 1: Moisture content in saithe fillets after chilled and frozen (1 week and 1 month) storage.

Tri-exponential fitting resulting in relaxation times ranging from 27 to 45 ms (T2a), from 60 to 99 ms (T2b) and from 187 to 341 ms (T2c).

- Injection of salt in combination with HFP(a) and/or gelatine resulted in the longest relaxation times, indicating that injection of these proteins affected the characteristics of these water pools the most.
- Addition of gelatine, alone or in combination with HFP(a) had no additional effects on the weight gain compared to fillets only injected with salt or HFP(a) respectively.

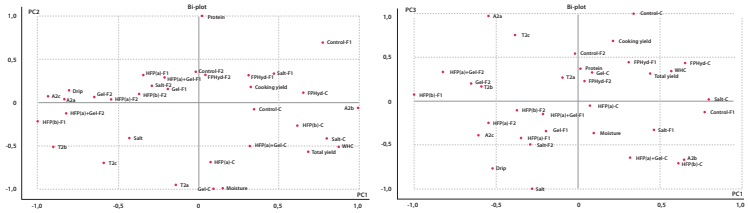

Figure 2: Weighted PCA bi-plot of scores and loadings for the first three PCs of saithe fillets injected with various protein brines after chilled storage(C), frozen storage for 1 week (F1) and frozen storage for 1 month (F2). PC1, PC2 and PC3 explained 38% 30% and 14% of the variation respectively.

- Transversal relaxation parameters gave significant correlations (p<0.05) to all physicochemical properties measured, except salt content and cooking yield (Figure 2 and Table 1).

Table 1: Transversal relaxation parameters with significant correlation to physicochemical quality parameters

Physicochemical quality parameter	Significant NMR parameter (tri-exp fit)
Drip	A_{2a},A_{2b},T_{2b}
Total storage yield	A_{2b},A_{2c}
Cooking yield	none
Total yield after cooking	T_{2a},A_{2b},A_{2c}
Moisture	A_{2a},T_{2a},A_{2b},T_{2b},T_{2c}
Salt	none
Protein	A_{2a},T_{2a},A_{2b},T_{2b}
WHC	A_{2a},T_{2a},A_{2b},T_{2b},T_{2c}

- Changes in the two shorter water pools indicated increased protein denaturation due to frozen storage and correlated to the changes of drip and water holding capacity.
- Water distribution and muscle structure was affected the most in the HFP(b) injected fillets frozen for 1 week and the HFP(a)+Gel injected frozen stored for 1 month.

Conclusions

Protein addition can stabilize and improve quality of saithe fillets, but the isolation processes, choice of concentrations etc. need to be optimized further to reach the desired functional properties of the muscle.

LF-NMR showed to be a useful tool in the study and gave valuable information about the changes in muscle structure caused by protein injection.

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