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A Note on the Effect of Long-Term Frozen Storage on Some Quality Parameters of Silver Smelt (*Argentinus silus*)

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Abstract

Samples of silver smelt, as fillets from frozen fish, as block-frozen fillets and as block-frozen mince, were thawed and tested for toughness (by shearing) and water-binding capacity after storage at –28°C for 150, 235 and 374 days; cryoprotectants were not used. Shear values fell over the storage period for fillets from frozen fish but remained relatively constant for the other two types of frozen material. Block-frozen fillets had the highest shear values. The water-binding capacities were lowest for block-frozen mince and decreased steadily over the three test dates for the three types of material.

Keywords: Freezing; quality evaluation; silver smelt (*Argentinus silus*)

Introduction

Silver smelt (*Argentinus silus*) is a non-quota deep-water fish species caught at many locations including the west coast of Ireland. Details of catching, handling and processing such fish on-shore, together with its suitability and use for fabricating products and analogues, have already been reported (Gormley, Ward and Somers, 1991 and 1992; Gormley, Molloy and Somers, 1992).

The purpose of the current study was to investigate the effect of long-term frozen storage on some quality parameters (i.e. shear value and water-binding capacity) of a commercial landing (in 1990) of silver smelt. The study was prompted by preliminary data which showed that frozen mince from 1989 was much tougher after a period of cold storage than freshly frozen mince from 1990 and also by comments from sources in the food trade that fishcakes and fingers made from silver smelt toughened during frozen storage.

Materials and Methods

Sourcing silver smelt

The fish were part of a commercial landing made at Killybegs, Co. Donegal in June 1990. They were held on board ship in refrigerated seawater (3°C) for 24 h before commercial freezing on-shore without the use of cryoprotectants as whole fish, block-frozen fillets or block-frozen mince. The frozen material was held in a commercial cold store at –28°C for three months. Samples for analysis were transferred to The National Food Centre by refrigerated truck where they were held at –28°C and evaluated after 150, 235 and 374 days post-freezing.

Tests and procedures

Both uncooked and cooked fish samples (100 g) were tested for toughness using a shear press fitted with a standard test cell as described by Gormley (1991). All measurements were made at 15°C. The frozen samples were thawed at ambient temperature for 10 h while cooking was carried out in polythene bags (ca 500 g fish) in water at 80°C to an internal fish temperature of 75°C; this took about 20 min.

Water-binding capacity of uncooked fish was assessed by measuring water loss on centrifugation (Wierbicki and Deatherage, 1958). The method uses fish flesh (2 to 4 g), glass beads with filter paper, and slow-speed centrifugation at 500 g for 10 min.

The shear and water-binding capacity tests were carried out in triplicate and the results were analysed using analysis of variance. Experimental design was 3 x 3 x 2 factorial combination of treatments with three replicates; i.e. 3 types of material (whole fish, block-frozen fillets, block-frozen mince), 3 times of testing (at 150, 235 and 374 days post-freezing); and cooked v. uncooked.

Results and Discussion

Shear tests

The results (Table 1) show a number of significant interactions. The shear values for fillets from frozen fish (both cooked and uncooked) fell considerably during the period of frozen storage while corresponding changes in block-frozen fillets were much smaller; it is difficult to explain this effect. Block-frozen mince toughened during frozen storage but this effect was negated by cooking. The high shear values for block-frozen fillets relative to fillets from frozen fish is also difficult to explain but may be due to tissue denaturation during filleting/freezing (Shenouda, 1980). The low shear values found for raw mince were probably an effect of comminution.

With the exception of fillets from frozen fish, changes in shear values during frozen storage were relatively small. This largely agrees with the findings of Krivchenia and Fennema (1988) who showed only slight toughening in burbot fillets, frozen without cryoprotectants and stored at –12°C over a 24-week period, and no toughening in those held at –60°C. However, these authors did

TABLE 1: The effect of type of fish material and duration of frozen storage on the shear values (kN) of raw and cooked silver smelt

Time (T) (days at –28°C)	Cooking (C)	Type of material (F)		
		Fillets from frozen fish	Block-frozen fillets	Block-frozen mince
150	Raw	1.34	1.82	0.38
	Cooked	1.66	1.92	1.88
235	Raw	1.11	1.84	0.43
	Cooked	1.33	2.17	2.00
374	Raw	1.06	2.02	0.54
	Cooked	0.95	1.71	1.94

Analysis of variance summary

Main effects	F-test	LSD	Interactions[1]	F-test	LSD
F	P<0.001	0.14	F x C	P<0.001	0.19
T	P>0.05	0.14	F x T	P<0.05	0.24
C	P<0.001	0.11	T x C	P<0.05	0.19

[1]The F x T x C interaction was not significant and the corresponding LSD was 0.33

TABLE 2: The effect of type of material and duration of frozen storage on the water-binding capacity of silver smelt fish pieces

Effect[1]	Centrifugal drip[2] (g/kg)	F-test	LSD
Type of material (F)			
Fillets from frozen fish	278	P<0.001	31
Block-frozen fillets	267		
Block-frozen mince	345		
Time (T) (days at –28°C)			
150	269	P<0.001	31
235	294		
374	327		

[1]No interaction between F and T
[2]Centrifugation at 500 g for 10 min

show that burbot fillets frozen with cryoprotectants were softer, over the 24-week storage period, than those frozen without cryoprotectants. Dingle and Lall (1979) showed that, based on extractable protein nitrogen (EPN), the minced flesh of silver smelt was very stable at –10°C in the absence of cryoprotectants. The EPN values decreased only very slowly whereas a rapid decrease in EPN is correlated with increased toughness of the cooked flesh (Dyer, 1951).

No information was obtained in the current study on changes in shear values during the first 150 days of frozen storage because the need to carry out a long-term study was not apparent at the time the fish were frozen. However, results from 1989 on uncooked fresh (i.e. non-frozen) silver smelt fillets showed a mean shear value of 1.24 kN which is lower than the values for fillets on the 150-day test date (Table 1).

Water-binding capacity

The water-binding capacity of the fish tissue, expressed as centrifugal drip (CD), is given in Table 2. The results are clear-cut in that the interaction between fish type and length of time at –28°C was not statistically significant. Block-frozen mince had a much higher CD than the fillets, indicating lower water-binding capacity; this result was also reflected in a separate study on the compressive strength of gels from silver smelt (Gormley *et al.*, 1992).

Length of frozen storage at –28°C influenced CD with a small but steady rise in values with time (Table 2). This result contrasts with those of Krivchenia and Fennema (1988) who found that CD values in burbot samples without cryoprotectants increased for the first four weeks of storage after which they remained relatively constant. Samson (1983) used burbot that had been frozen for six months at –40°C prior to the first test date; he found that samples stored at –7°C or –40°C maintained a relatively constant CD during 45 days of storage.

No CD tests were carried out in the current study in advance of the 150-day test date for the reasons given above. However, the results, thereafter, suggest that the effect of cryoprotectants in halting the decline in CD values during long-term frozen storage should be investigated.

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