Rannsóknastofnun fiskiðnaðarins

Effect of Natural White * treatment on redfish fillets during frozen storage

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CONTENTS

1. INTRODUCTION

This report describes work for JA Consulting International on dipping experiments and shelf life testing during frozen storage on fresh frozen and twice-frozen redfish (*Sebastus marinus*) fillets. The purpose of this work was to evaluate the effectiveness of two types of dipping agents (*Natural White** and *Natural White-S**) on the quality and shelf life of redfish fillets during frozen storage. This was done by measuring fillet colour, TBA, weight changes and carrying out sensory analysis on fillets at the beginning of frozen storage and after 3, 6 and 12 months storage at -25°C. In this report results for the first 3 months frozen storage can be found.

2. MATERIALS AND METHODS

2.1. Raw material

Redfish (*Sebastus marinus*) was caught in trawl on Garðskagi-fishing ground, South-West of Iceland on the 2nd of September 1996. The fish was treated in the normal way for redfish, i.e. neither bled nor gutted prior to thorough icing in an insulated plastic tub, until processed on the next day. The fish was processed after one day ice strorage shile it was still in rigor mortis. The fish were headed and filleted in a redfish filleting machine. Fillets with skin on were used for the trials. All fillets for the trials were chosen randomly. The fillets average weight was 167±50 g.
Redfish (*Sebastus marinus*) for use in the refrozen experiment was caught in Greenland sea territory on the 27th of July 1996. The fish was processed on board a freezer trawler. The fish was headed, gutted and packed in wax coated cartons (7 kg) and then frozen in a plate freezer prior to final packing of 3 cartons together in pap boxes for keeping in frozen storage. Final processing took place in land. The fish was removed from the cartons into isolated plastic tubes and defrosted in running water (18°C) for 4-5 hours. Directly after defrosting, ice was added to the tubes. The fish was filleted in a redfish filleting machine. Fillets with skin on were kept in isolated fish tubes in icewater for approximate 6 hours prior to further handling. All fillets for the trials were chosen randomly. The fillets average weight was 102±28 g.

2.2. Experimental setup

Both fresh and defrosted fillets were dipped in *Natural White* (NW*)* or *Natural White-S* (NW-S*)* solution. Control consisted of undipped fillets. This gave a total of 6 trial groups of redfish fillets, that were named F-NW (frozen, dipped in *NW**), F-NW-S (frozen, dipped in *NW-S**), F-None (frozen, no dipping), TF-NW (twice-frozen, dipped in *NW**), TF-NW-S (twice-frozen, dipped in *NW-S**) and TF-None (twice-frozen, no dipping). *NW** and *NW-S** were produced and provided by JA Consulting International. Dipping of fillets was carried out by the producer. The fillets were

dipped in 2% (v/v) *NW** or 2% (v/v) *NW-S** water solution for 10 seconds. The producer claims that *NW** and *NW-S** contain rosemary extract from Kalsec Inc. (Kalamazoo), calcium chloride and citric acid and are all considered GRAS (generally recognised as safe). *Natural White-S** (S = super) is a special product that contains 6 of 7 isomers of rosemary and is supposed to have less odour than *NW**. *NW** and *NW-S** are to be used as additives and therefore must be approved by the appropriate authorities. IFL is not aware of such an approval in Iceland, EC or USA.
After dipping, individual fillets were spread on a freezing pan and frozen over night in a pan freezer. Then the fillets were packed in plastic bags, 21 fillets in each bag and two bags packed together in a cardboard box. One bag from each group was measured after 1 week, 3, 6 and 12 months frozen storage at -25°C. For each sampling there were used 21 fillets, 12 fillets for measurement on colour- and weight changes and sensory analysis (4 fillets as 1 sample) and 9 fillets for TBA measurement (3 fillets as 1 sample).

2.3. Weight changes measurements

Fillets were labelled in the tail with an unremovable numbered plastic label (10 x 35 mm) and weighted before treatment. On sampling, fillets were drained for 1 minute on a wire frame and reweighted. Weight changes are defined by;
Weight changes = $((W_s - W_0) / W_0) \times 100$

W_s: Weight of fillet at sampling
W_0: Weight of fillet before treatment

2.4. Colour measurements by Chroma meter

The flesh colour of raw fillets with skin on was measured by a Minolta CR-300 Chroma meter in the L*a*b* measuring mode. According to the instruction manual, the L*a*b (CIE 1976) colour system represents human sensitivity to colour. Equal distances in this system approximately equal perceived colour differences. L* is the lightness variable (L* = 100 is white and L* = 0 is black), a* and b* are the chromaticity coordinates, where +a* stands for red and -a* stands for green, whereas +b* stands for yellow and -b* stands for blue. For evaluation of change in colour by time, labelled fillets were measured for L*a*b values before treatment and then again on sampling. The same fillet was measured in three locations, giving the average value for colour of head, middle and tail region of each fillet. Results are given as ΔL*, Δa*, Δb*.

2.5. TBA- value

Fillets were skinned and minced, prior to measurement of TBA-value, by the method of Tarladgis et al., (1960), using steam distillation and antioxidants as described by Vyncke, (1975).

2.6. Sensory colour evaluation

The flesh colour of fillets was evaluated on raw fillets with skin on, by four to five people from IFL sensory group. Colour evaluation was based on a three point scale for iced redfish fillets. The scale for sensory evaluation of flesh colour is shown in Appendix 1.

2.7. Sensory analysis

Sensory analysis was carried out on cooked fillets. The fillets were cooked in Convostar steam oven (Convotherm, Germany) at 100°C. Ten to twelve IFL panellists participated in the sensory analysis. Three samples from each treatment group were evaluated individually on each sampling. Scales for all sensory components are shown in Appendix 1. The freshness scale describes characteristics of redfish during storage. The intensity scale for taint describes if there is any taint or uncommon odour or taste and how much. The texture of fillets was evaluated by the texture factors succulent to dry and tender to tough on a linear scale from 100 to 0. These texture profiles describe texture on chewing. All scales except the colour evaluation scale are continuous.

2.8. Statistical analysis

Calculations on all results are based on average for each sample group. Tukey HSD multiple comparison method was used to find if significant difference ($p \leq 0.05$) was between averages of sample groups for each sampling.

3. RESULTS

3.1. Weight changes

Results from measurement on average weight changes during frozen storage are shown in Figure 1. There was no significant difference between any groups shortly after freezing (8 days frozen storage). After 3 months frozen storage the weight loss is much less in the twice-frozen, treated groups (TF-NW and TF-NW-S) than matching once frozen groups, but the difference was not significant in the case of F-NW-S. TF-None group lost the most weight and was significantly different from other groups, except the F-NW group, that lost the next most weight. The F-NW group was also significantly different from the other treatment groups, except F-NW-S group.

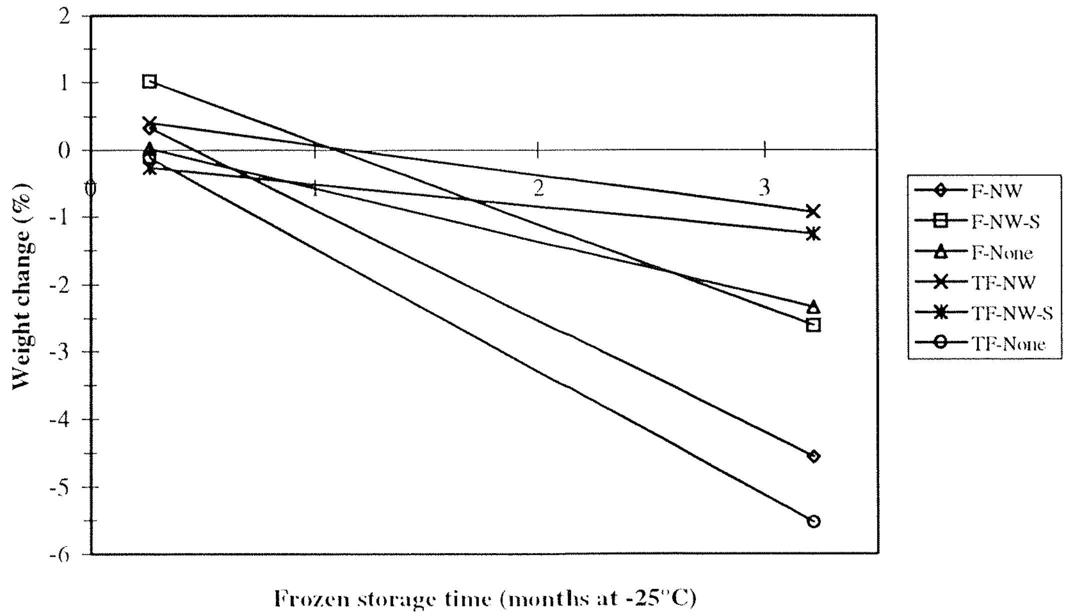

Figure 1. Weight changes in redfish fillets with treatment and storage time.

3.2. Colour change

Results of sensory panel evaluation of fillet flesh colour by time are shown in Figure 2. Colour scale is shown in Appendix 1. In general there was more change in colour during frozen storage in the once frozen groups than in the twice-frozen group.

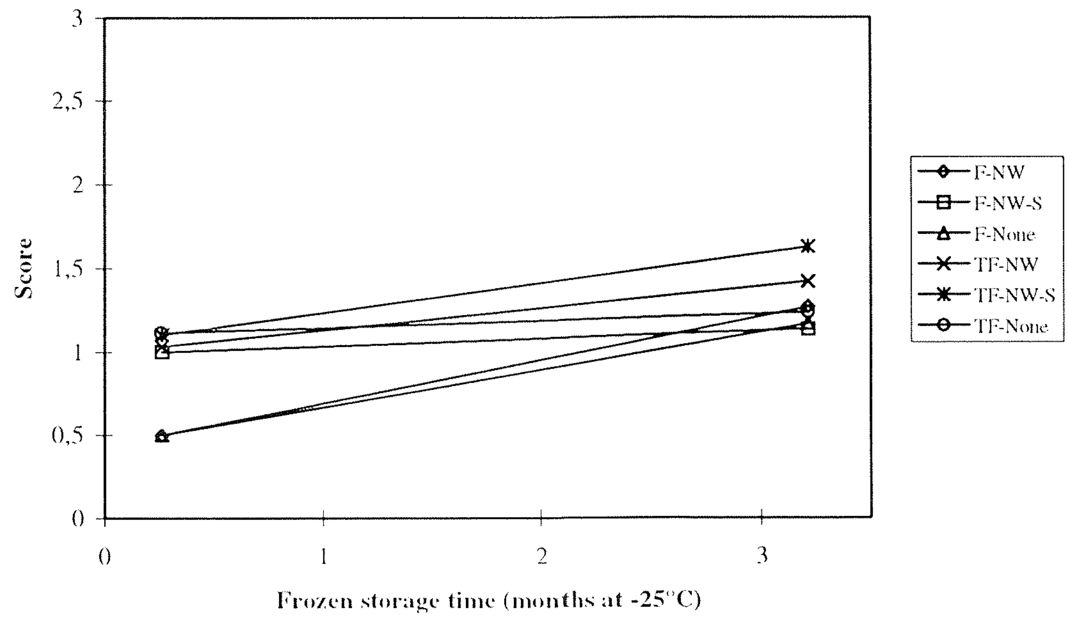

Figure 2. Sensory evaluation on colour of fresh frozen and twice-frozen redfish fillets treated with different additives and held in frozen storage.

Very little changes were observed in colour for the F-NW-S and the TF-None groups during the 3 months frozen storage. The groups F-NW and F-None were significantly different from the other groups shortly after freezing, possible indicating that these groups were fresher. There was no significant difference between groups after 3 months frozen storage.

Results of L*a*b* colour measurement are shown in Table 1. The values for a* and b* of groups TF-NW and TF-NW-S after 98 days (3 months) frozen storage are missing, due to technical mistake.

Table 1. Mean colour values L*, a* and b* for fresh frozen and twice-frozen redfish fillets treated with different additives and held in frozen storage.

	Storage time, days at -25°C								
	0			8			98		
Group	L*	a*	b*	L*	a*	b*	L*	a*	b*
F-NW	44,8±2,3	1,1±0,9	-1,6±0,8	46,1±1,4	0,7±0,5	0,4±0,5	47,0±2,2	0,4±0,9	2,0±1,2
F-NW-S	43,7±1,7	1,1±0,7	-1,2±0,8	47,2±1,6	0,2±0,5	0,6±0,7	45,7±1,7	0,5±0,4	2,1±0,9
F-None	43,4±2,1	1,0±0,6	-1,4±0,7	44,2±1,5	0,9±0,8	1,5±0,9	44,1±1,4	0,3±0,4	2,4±0,8
TF-NW	49,9±2,1	0,8±0,5	0,4±0,9	50,4±1,8	-0,1±0,2	0,4±1,1	48,6±1,7		
TF-NW-S	50,1±1,9	0,7±0,5	0,4±1,1	50,6±2,3	0,1±0,5	1,7±1,2	48,7±1,4		
TF-None	50,1±1,7	0,7±0,5	0,5±1,0	48,9±2,1	0,1±0,5	1,3±1,1	49,1±1,7	0,5±0,3	2,4±0,7

At day 0 the mean consisted of values form 48 fish, whereas means for day 8 and 98 were computed for 12 fish, combining values for three locations on each fillet in every case.

L* values stand for lightness on a scale from 0 to 100, where 100 is white. Twice-frozen groups had higher initial L* values, than once frozen groups ($p=0,05$), (indicating less fresh raw material). All groups got higher L* values shortly after freezing (8 days), except the TF-None group that got lower L* value. L* values changes variable after 3 months (98 days) frozen storage. The average change in L* (ΔL^*) during time is shown in Figure 3.

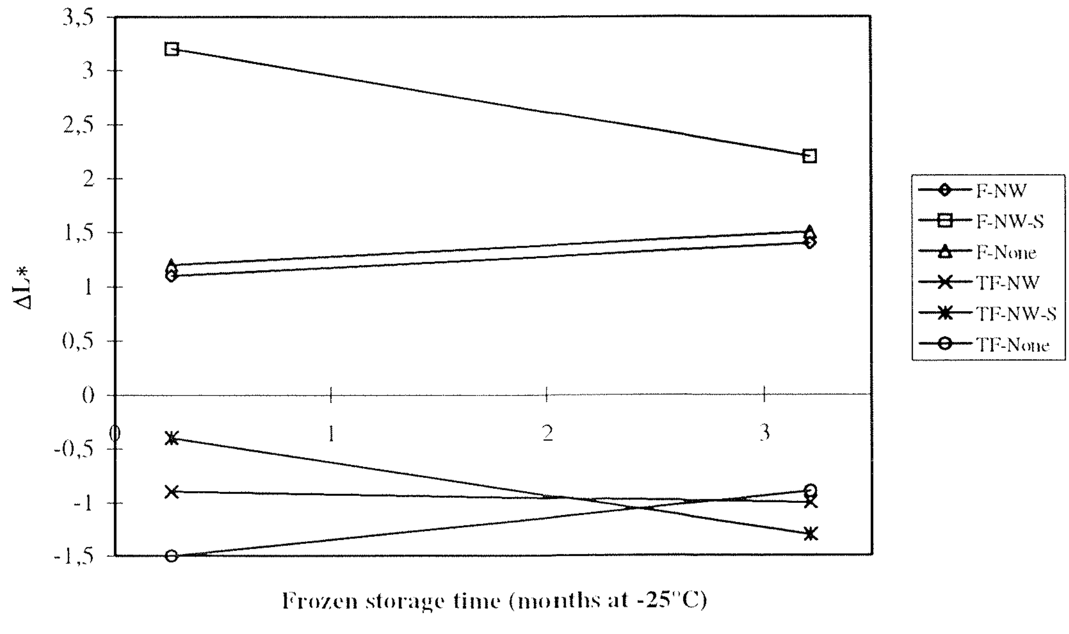

Figure 3. Change in ΔL of redfish fillets with treatment and storage time.*

The first measurement shortly after freezing showed that the change in L* (ΔL*) was towards -L* values for the TF, that is darkening, but the opposite was taking place for the F groups, that is they were becoming lighter. The ΔL* was higher in the F-NW-S group than in any other group, and this was a significant difference. ΔL* in groups F-NW and F-None was also significantly different from the TF groups, except TF-NW-S. After still 3 months frozen storage there was a significant difference between all of the F groups and all of the TF groups.The chromaticity coordinate +a* stands for red and -a* for green. All groups show low +a* values, that decline after freezing (see Table 1). The initial a* values in the TF-NW group were significantly lower than in the F-groups. Shortly after freezing the F-None group was significantly different from the TF groups. The average change in a* (Δa*) during frozen storage is shown in Figure 4. There was no significant difference in Δa* between groups at either 8 days or 98 days frozen storage.

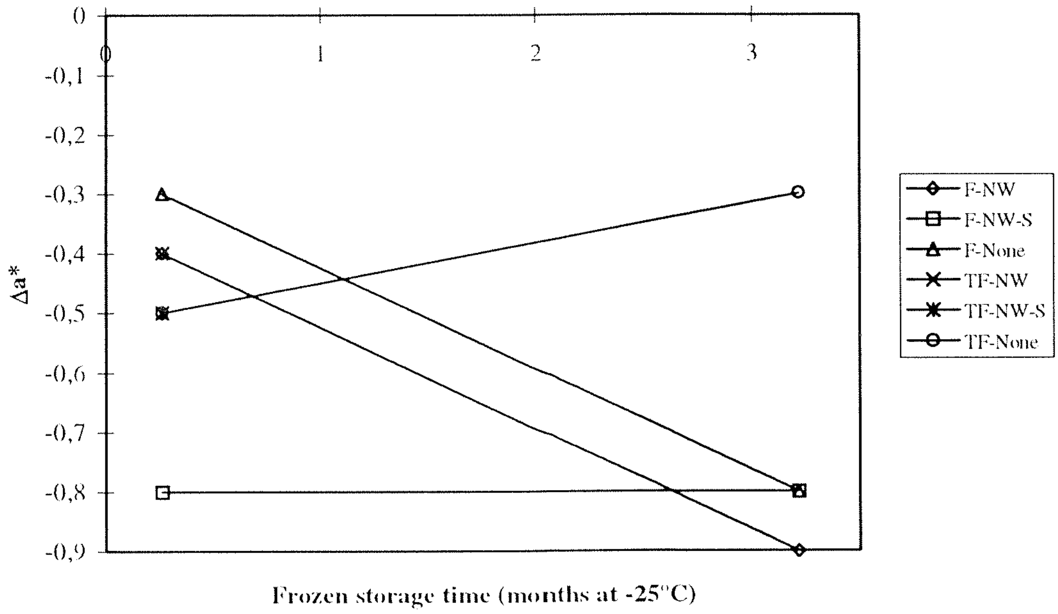

Figure 4. Change in Δa of redfish fillets with treatment and storage time.*

The chromaticity coordinate +b* stands for yellow and -b* stands for blue. All F-groups show low -b* values in the beginning, but the TF-groups show low +b* values and this difference between groups was significant. All trial groups turns towards +b* values with time (see Table 1). The average change in b* (Δb*) during time is shown in Figure 5. There was a significant difference in Δb* between the F-groups and the TF-groups after 8 days frozen storage. The F-none group shows the highest change in b* with a significant difference between all groups, except F-NW. After 3 months frozen storage the Δb* in all F-groups was still significantly different from TF-None group.

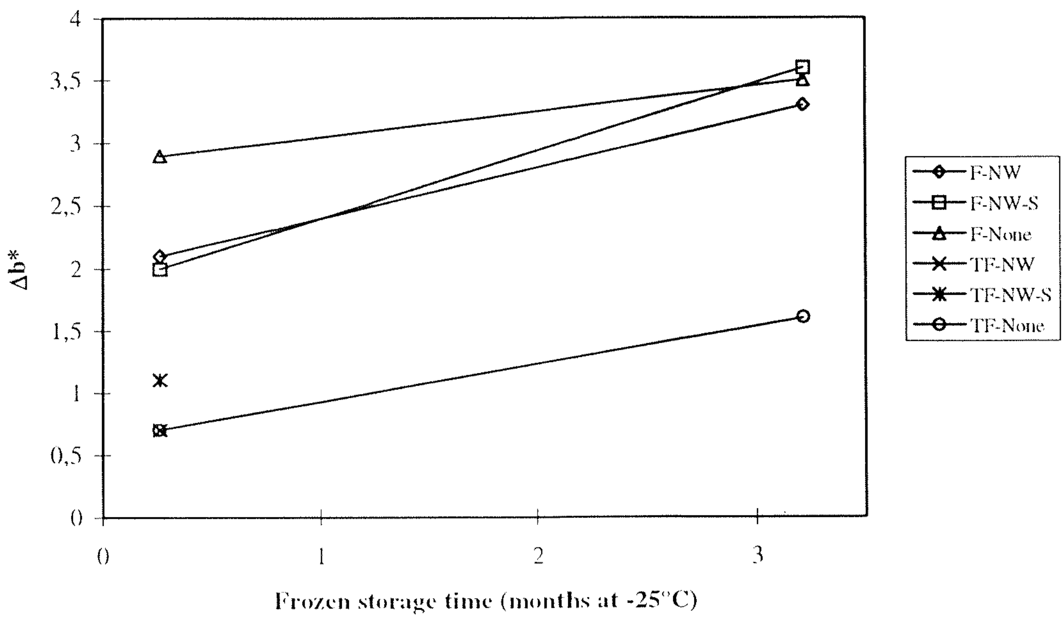

Figure 5. Change in Δb of redfish fillets with treatment and storage time.*

3.3. TBA-value

Results of TBA-values are shown in Figure 7. TBA-value in the once frozen raw material for was almost zero prior to the second freezing, but rises considerably after freezing and further eight days frozen storage. None dipped groups show highest values in TBA for both once and twice-frozen redfish fillets after eight days frozen

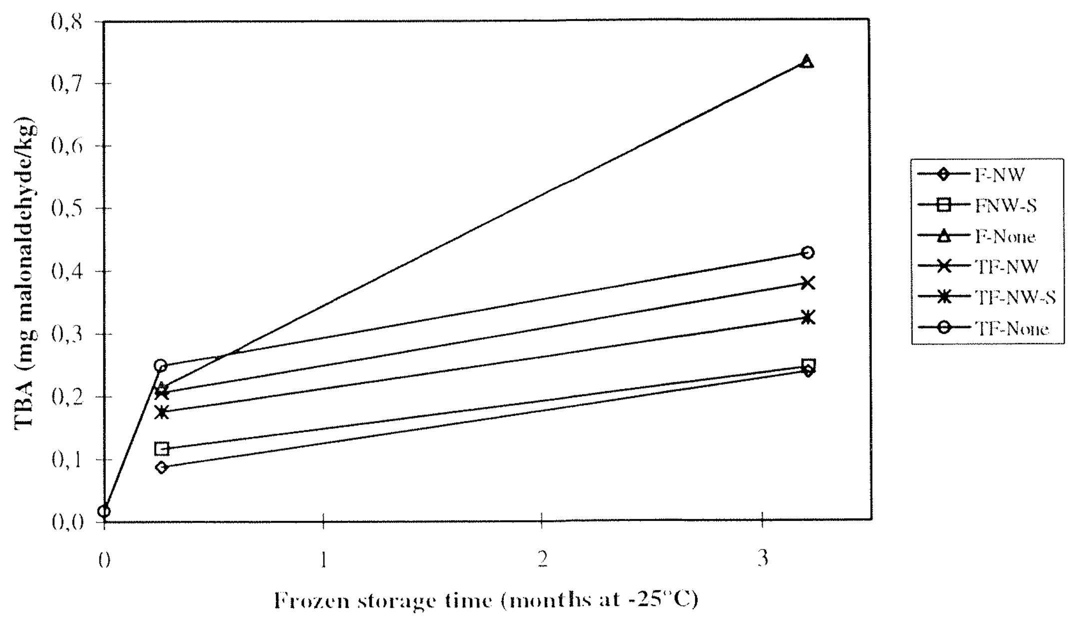

Figure 6. TBA-values in fresh frozen and twice-frozen redfish fillets treated with different additives and held in frozen storage.

storage. But there was only significant difference between the TF-None group and the treated, once frozen groups (F-NW and F-NW-S) after eight days frozen storage. After 3 months frozen storage there is a increase in TBA value in all groups, but the increase is the most in the F-None group. There was a significant difference between the F-None group and all other groups, except the TF-None group.

3.4. Sensory analysis

Results of sensory analysis of cooked redfish fillets are shown in Figures 7 to 10. All scales are compiled in Appendix 1. Evaluation of freshness is shown in Figure 7. At the beginning of frozen storage there was a significant difference between the TF-groups and the F-groups, except the F-NW-S group. After 3 months frozen storage there was a significant difference between F-NW and all of the TF-groups. There was also a significant difference between F-NW-S and the TF-groups, except the TF-NW-S group and between F-None and TF-None.

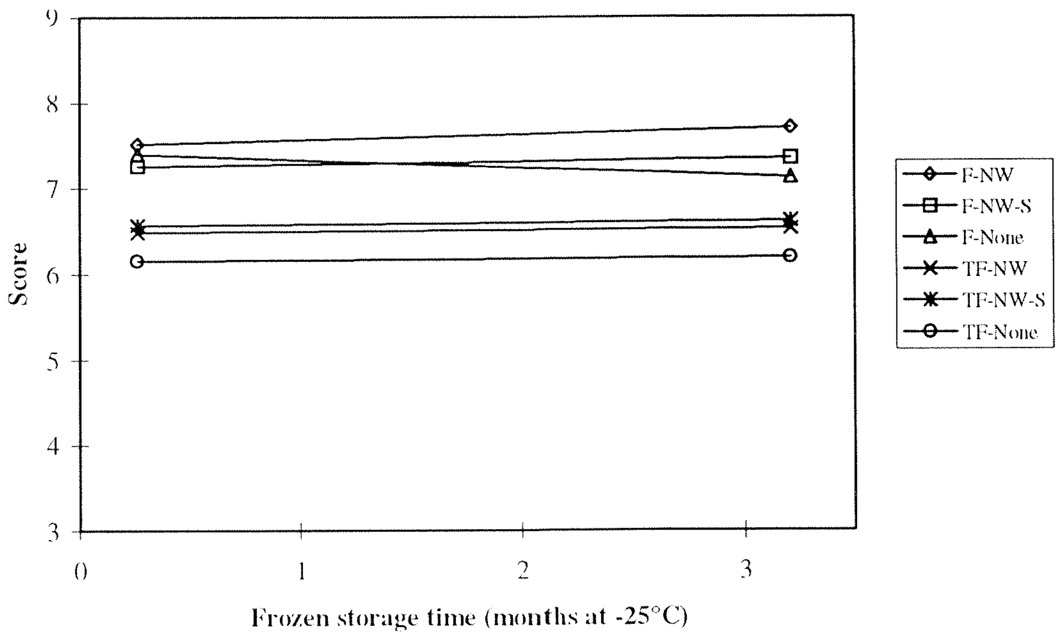

Figure 7. Sensory analysis on freshness of fresh frozen and twice-frozen redfish fillets treated with different additives and held in frozen storage.

Results on evaluation of taint or aftertaste in cooked redfish fillets are shown in Figure 8. Taint was under or at the threshold limits in all groups, except the NW-S treated groups. After 8 days frozen storage there was a significant difference between TF-NW-S and all other groups and F-NW-S was also significant different form F-NW group. After 3 months frozen storage there was a significant difference between the NW-S treated groups and all other groups. Taint from dipping with *NW-S** seemed to rise during 3 months frozen storage.

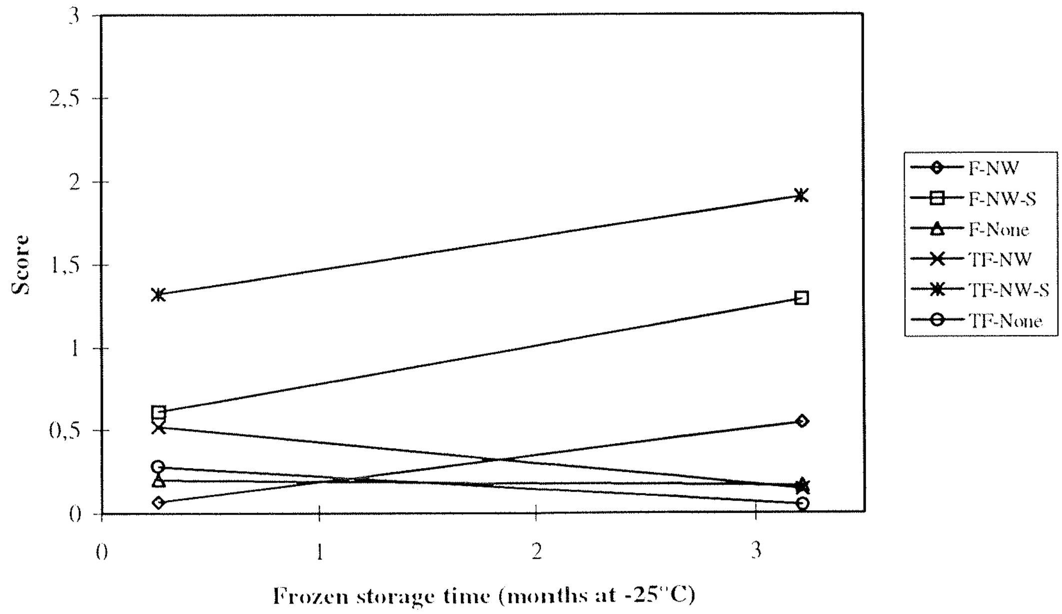

Figure 8. Sensory analysis on taint in cooked fresh frozen and twice-frozen redfish fillets treated with different additives and held in frozen storage

Results of texture profiles on cooked redfish fillets are shown in Figures 9 and 10. Scores for dry-succulent texture are somewhat lower for the TF-groups, but the difference was only significant at beginning of frozen storage for the TF-NW-S and the F-groups and also between TF-NW and the F-groups, except F-NW. After 3 months frozen storage there was much less difference between groups, but there was a

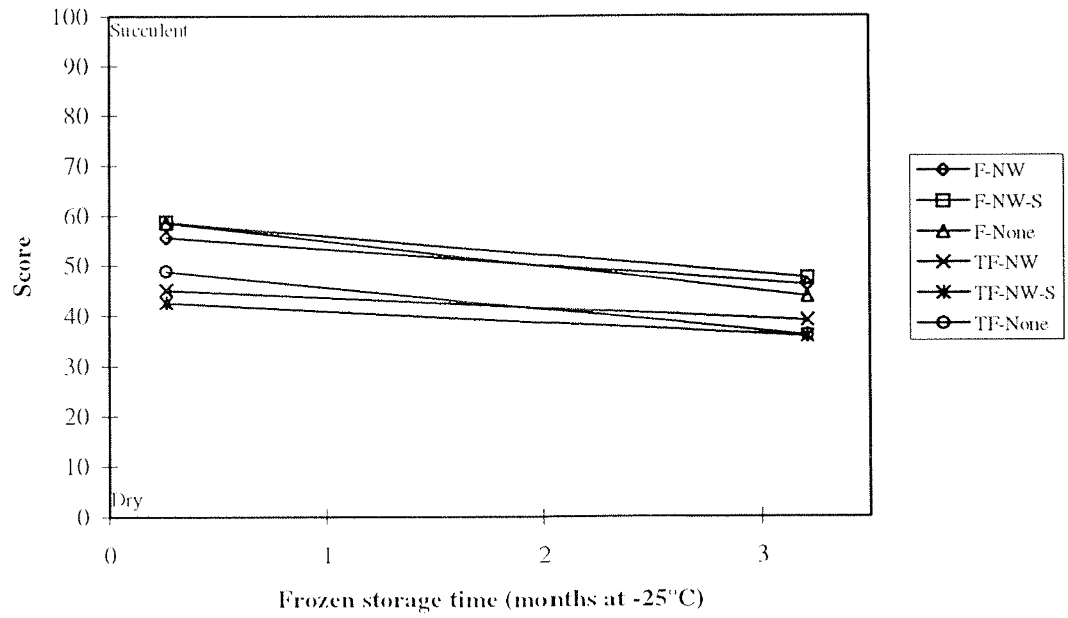

Figure 9. Texture profile (dry-succulent) by sensory analysis of cooked fresh frozen and twice-frozen redfish fillets treated with different additives and held in frozen storage.

significant difference between both F-NW-S and F-NW-S and the TF groups, except TF-NW. All groups were judged dryer in texture after 3 months frozen storage than the initial scores.

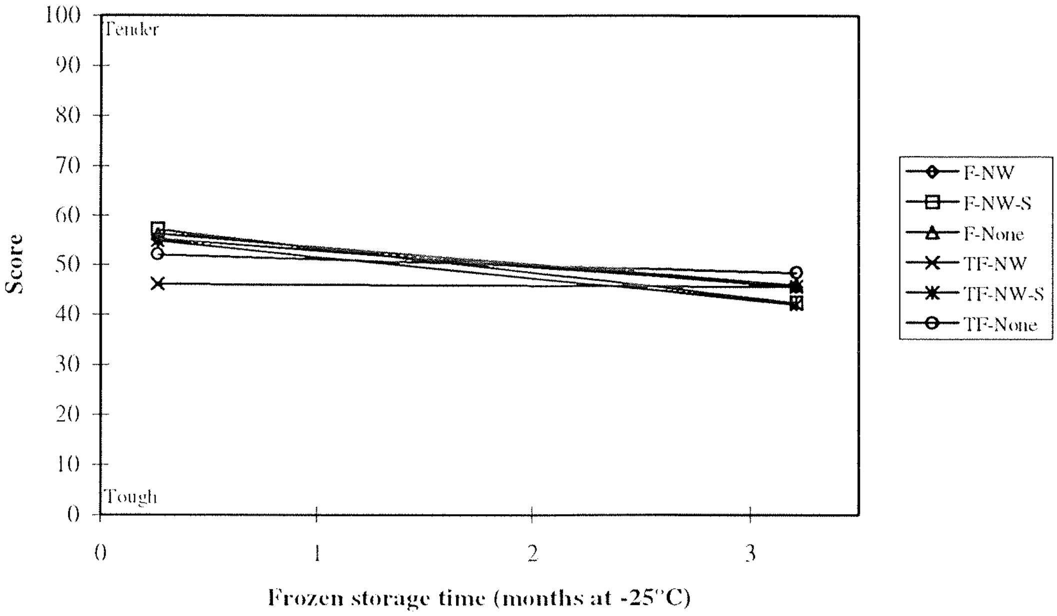

Figure 10. Texture profile (tender-tough) by sensory analysis of cooked fresh frozen and twice-frozen redfish fillets treated with different additives and held in frozen storage.

Scores for tender-tough texture were similar for all groups, except for the TF-NW group that had considerably lower initial scores than other groups, but there was no significant difference between groups. Scores after 3 months frozen storage were in all cases lower than the initial scores, except for TF-NW that did not change during 3 months frozen storage.

4. CONCLUSIONS

Treatment with *NW** or *NW-S** on twice-frozen redfish fillets did considerably reduce weight loss during 3 months frozen storage, compared to no treated control. *NW** or *NW-S** did on the other hand not reduce weight loss in once frozen redfish fillets. On the contrary the *NW**-treated fillets lost more weight than the control.
Results on treatment with *NW** or *NW-S** did not indicate colour improvement during 3 months frozen storage on either once or twice-frozen redfish fillets. Whether measured by a Chroma meter or with sensory evaluation.
Treatment with *NW** or *NW-S** did hinder rancidity as measured by TBA value. The controls showed highest values in TBA for both once and twice-frozen redfish fillets. The TBA-values were somewhat higher in the once frozen groups, than in the comparable twice-frozen groups.
Treatment with *NW** or *NW-S** did not improve judgement on freshness by sensory analysis in either once or twice-frozen redfish fillets during 3 months frozen storage.

Dipping with *NW*-S* did cause a taint in both once and twice-frozen, cooked redfish fillets. This taint was recognised from the start of the frozen storage and increased during 3 months frozen storage and was then very slight to little. Taint was under or at the threshold limits in *NW** treated groups and in the controls.
Treatment with *NW** or *NW-S** did not affect the texture of either once or twice-frozen redfish fillets during 3 months frozen storage.

5. REFERENCES

Vyncke, W. (1975). Evaluation of the direct thiobarbituric acid extraction method for determining oxidative rancidity in mackerel (*Scomber scombrus L*). Fette Seifen Anstr., 72, 12.

Tarladgis, B. G., Watts, B. M. and Younathan, M. T. (1960). A distillation method for the quantitative determination of malonaldehyde in rancid foods. JAOCS, 37, 44.

APPENDIX 1. Scales for sensory analysis

Freshness score sheet for iced redfish cooked fish

Score	Odour	Flavour
10	Initially weak odour of boiled cod liver, fresh oil, starchy	boiled cod liver Watery, metallic
9	Shellfish, seaweed, boiled meat, oil, cod liver	oily, boiled cod liver Sweet, meaty characteristic
8	Loss of odour, neutral odour	Sweet and characteristic flavours but
7	Woodcarvings, woodsap, vanillin	Neutral
6	Condensed milk, boiled potato	Insipid
5	Milk jug odourous boiled clothes- like	Slight sourness, trace of "off"-flavours, rancid
4	Lactic acid, sour milk TMA	Slight bitterness, sour, "off"-flavours, TMA, rancid
3	Lower fatty acids (e.g. acetic or butyric acids) composed grass, soapy, turnipy, tallowy	Strong bitter, rubber, slight sulphite, rancid

Intensity scale for taint

0 None

Scale for redfish flesh colour

0 Like transparent