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Effect of Preprocess Ice Storage on the Lipid Changes of Japanese Threadfin Bream *(Nemipterus japonicus)* Mince during Frozen Storage

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Abstract

Holding of Japanese threadfin bream *(Nemipterus japonicus)* on ice before mincing and freezing resulted in significant changes in peroxide value (PV), free fatty acids (FFA), thiobarbituric acid (TBA) number, salt-soluble proteins (SSP) and flavor scores.

During frozen storage, the increase in PV, TBA and FFA correlated significantly ($P<0.05$) with the decrease in SSP. Further, lipid parameters and SSP influenced the quality of the mince with respect to flavor score ($P<0.05$) indicating that these parameters are useful for determining the stability of the mince during frozen storage. The quality of frozen stored mince (-18°C) obtained from 0, 3, 5, 11 and 14 d ice-stored Japanese threadfin bream was 'acceptable' up to 138, 120, 86, 62 and 7 d, respectively.

Introduction

Pink perch fishery is the main shrimp by-catch of Indian coastal waters. Owing to its small size, odd appearance and bony nature, a greater portion of the catch is used for reduction purposes. However, the low-priced fish is presently evolving towards increased utilization for production of human food. With the development of mechanical deboning and mincing, one way to profitably use this fish is to produce mince which can serve as a base for several culinary preparations.

In India, a variety of marine products are stored and marketed in frozen state, as freezing and frozen storage are important methods of preserving fish and fishery products. Although freezing of shrimp by-catch mince has potential application in the preparation of value-added products like fish sticks, fish

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cakes, fish balls, fish fingers, etc., both for domestic consumption and for export, certain changes occur during frozen storage which reduce its shelf-life due to the autooxidation and hydrolysis of lipids (Joseph et al. 1989).

To support the current interest in this area, there is a need for more information on the stability and hence the acceptability of different fish minces during frozen storage. This study attempts to determine the effect of postmortem holding of Japanese threadfin bream *(Nemipterus japonicus)*, known locally as pink perch, on ice on the lipid parameters of fish mince during frozen storage. Pink perch is a major by-catch of shrimp fishery in India's coastal waters, contributing approximately 3.5% of total marine landings in India.

Materials and Methods

N. japonicus caught off the Mangalore coast were iced on board the vessel in the ratio of 1:1, washd in ice-cold water in the processing hall and held on ice in an insulated box maintained at 2 ± 1°C.

Samples of fish drawn on 0 (fresh), 4, 6, 12 and 15 days of iced storage (hereafter designatd as F_1, F_2, F_3, F_4 and F_5, respectively) were dressed, washed with chilled water, and stored on ice, ready for deboning. Fish mince was prepared from dressed fish using a mechanical deboner (Model S-3, Toyo Seikon Kaisha Ltd., Japan) and mincer (Model M-3, Toyo Seikon Kaisha Ltd., Japan).

From each of the ice-treated samples, 500 g of mince was packed in rectangular metal freezing trays lined with polythene sheets, and frozen by keeping the products in between the evaporative coils of the cold storage maintained at -20°C. After 48 h, the frozen mince was stored in low-density polythene bags at -18°C in 3-ply carton boxes. Changes in lipid characteristics of mince during frozen storage were determined immediately after mincing and at 30-day intervals for frozen-samples drawn randomly.

Analyses

Total lipid was extracted from the samples by the method of Bligh and Dyer (1959), peroxide value (PV) of the lipid extract was measured following the method of Jacobs (1958), and thiobarbituric acid (TBA) number by the procedure of Tarladgis et al. (1960). Estimation of free fatty acids (FFA) was according to Takagi et al. (1984). Salt-soluble proteins (SSP) were extracted by the procedure of Vidya Sagar Reddy and Srikar (1991) and protein content was determined in the extracts by the procedure of Gornall et al. (1949).

Sensory Evaluation and Statistical Analysis

Pink perch mince was steam cooked with 2% salt in the mince for 10 minutes, cooled and presented (within 20 minutes) to a minimum of eight trained panelists for assessing the sensory attribute 'flavor' using a 10-point hedonic scale (excellent - 10.0, very good - 8.0, good - 6.0, acceptable - 4.0, not acceptable - <4.0) (Vidya Sagar Reddy and Srikar 1991).

Data from the chemical analysis were subjected to two-way ANOVA to determine differences between holding time on ice and frozen storage. Least significant difference (based on Duncan's 't' test) was found between frozen storage period for each sample and between samples at a given frozen storage period. Correlation coefficients between the SSPs, with hydrolyzed and oxidative products of lipids and their relationship with organoleptic quality (flavor) were established. The shelf-life of the product was determined using a linear regression between the mean sensory scores for flavor and storage period.

Results and Discussion

The effect of preprocess holding of fish on ice prior to deboning and freezing, revealed no significant variation ($P>0.05$) in total lipid content of the mince (0.62 ± 0.07%) between the treatments and during frozen storage.

Preprocess holding of pink perch on ice prior to freezing exerted a profound influence on the formation of peroxides through oxidative deterioration (Fig. 1a). A significant increase ($P<0.05$) in PV was noticed during the first 120 d storage in samples F_1 and F_2, 90 d in F_3 and F_4, and 60 d in F_5. A slight decrease ($P>0.05$) in PV was observed during the later part of the storage. The decrease may be due to the secondary reactions of the carbonyl compounds and volatilization. Hydroperoxides are useful indicators of oxygen uptake only in the early state of oxidation (Perez-Villareal and Howgate 1991), hence a significant ($P<0.05$) increase was observed during the initial storage period.

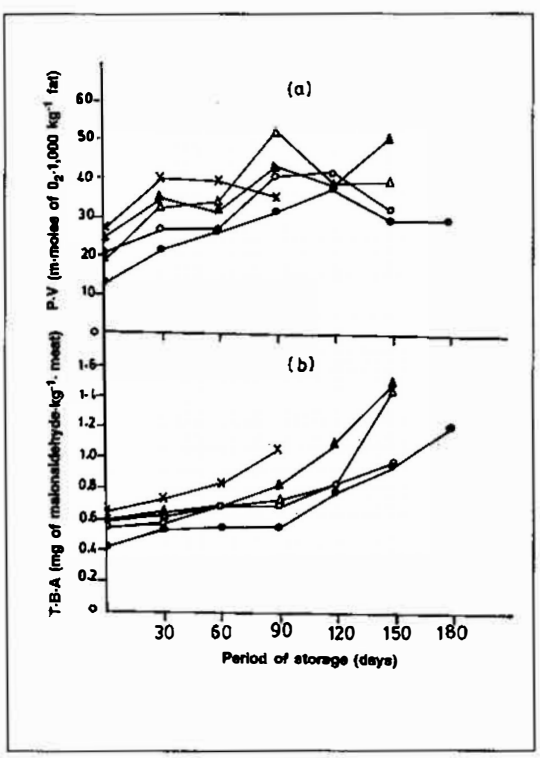

Fig. 1. Changes in the peroxide value (PV) (1a) and thiobarbituric acid (TBA) (1b) number of frozen-stored pink perch mince. Fresh (0 d) [●—●], 3 d [○—○], 5 d [▲—▲], 11 d [Δ—Δ], 14 d [x—x].

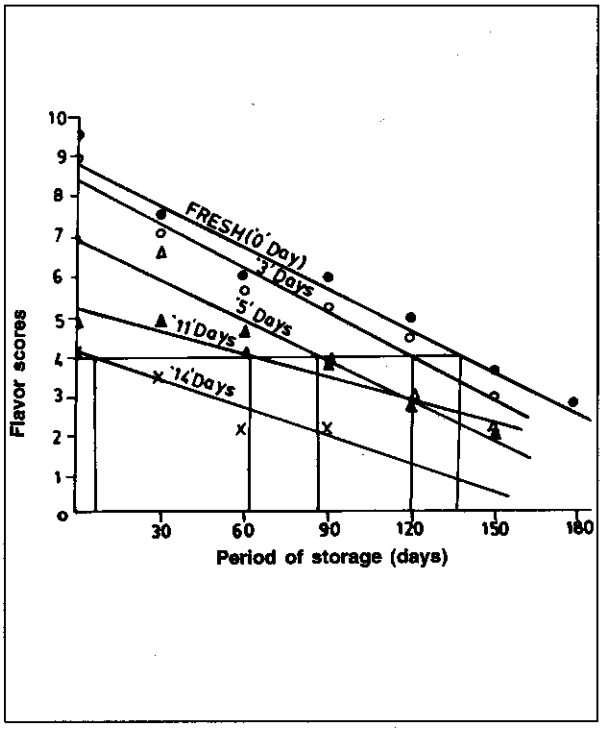

Fig. 2. Sensory evaluation of pink perch mince stored at -18°C based on flavor scores. Plot of linear regression with time. Fresh (0 d) [●–●], 3 d [○–○], 5 d [▲–▲], 11 d [Δ–Δ], 14 d [x—x].

A significant increase in TBA number was observed during frozen storage of all the samples (F_1 - F_5), and delay in processing of fish prior to freezing led to increased TBA values during subsequent frozen storage (Fig. 1b). Mechanical deboning and mincing accelerate oxidative change via the separation of fat from tissue and skin (Webb et al. 1976) and via physical surface effects (Mai and Kinsella 1980).

FFA levels were lowest in fresh fish mince (F_1) and increased with holding time on ice prior to mincing. An increase ($P<0.05$) in FFA among all the samples (F_1 - F_5) during storage indicates hydrolysis of lipids (Table 1). Preprocess holding of fish on ice prior to freezing significantly reduced SSP (Table 1). Significant reduction of myofibrillar proteins occurred during the first 120, 90, 90, 60 and 30 d in F_1 , F_2 , F_3, F_4 and F_5 samples. It is evident that myofibrillar protein denaturation during frozen storage depended upon the initial condition of the raw material. Lipid oxidation products and FFAs formed during frozen storage of fishery products are known to influence the solubility of proteins (Srikar et al. 1989). Interaction of oxidized lipids with fish proteins such as cysteine SH, the Σ - NH_2 group of lysine and the N - terminal group of aspartic acid, tyrosine, methionine and arginine (Kussi et al. 1975) are also known to influence the solubility of SSP. In the present study, a significant inverse relationship existed between SSP and PV ($P<0.001$ for samples F_1 and F_5, $P<0.05$ for F_2 , F_3 and F_4) and between TBA and SSP in all the samples ($P<0.05$) during their respective frozen storage periods. According to Sikorski et al. (1976), FFA may react hydrophobically or hydrophillically at appropriate sites on pro-

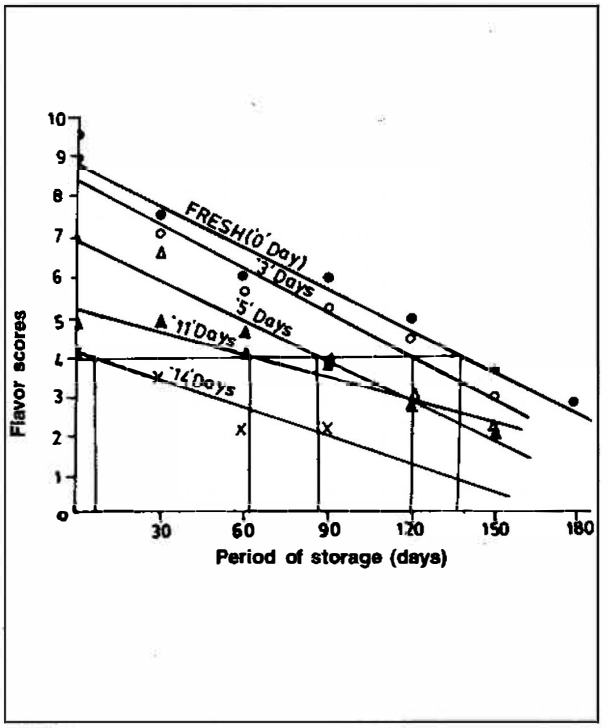

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Table 1. Free fatty acid (FFA) and salt-soluble protein (SSP) contents of pink perch mince during frozen storage.

Parameter	FFA* (% of total lipid as oleic acid)					SSP* (%)				
Storage at -18°C (d)	Treatments F_1	F_2	F_3	F_4	F_5	F_1	F_2	F_3	F_4	F_5
0	3.73^{a}_{1} (0.01)	5.66^{a}_{2} (0.28)	6.91^{a}_{2} (0.27)	12.65^{a}_{3} (0.0)	13.31^{a}_{3} (0.27)	9.31^{a}_{1} (0.56)	8.95^{a}_{1} (0.43)	8.71^{a}_{1} (0.02)	7.40^{a}_{2} (0.15)	7.02^{a}_{2} (0.14)
30	5.99^{b}_{1} (0.24)	8.54^{b}_{2} (0.53)	11.10^{b}_{2} (0.63)	13.28^{a}_{3} (0.0)	12.68^{a}_{3} (0.16)	6.06^{b}_{1} (0.17)	7.51^{b}_{1} (0.21)	5.89^{b}_{2} (0.18)	4.95^{b}_{2} (0.36)	4.20^{b}_{2} (0.13)
60	9.57^{c}_{1} (0.0)	11.63^{c}_{2} (0.0)	13.57^{c}_{2} (0.25)	11.55^{a}_{2} (0.0)	15.62^{b}_{3} (0.01)	6.06^{b}_{1} (0.21)	5.09^{c}_{12} (0.29)	4.86^{c}_{23} (0.06)	4.30^{c}_{3} (0.09)	3.87^{bc}_{3} (0.07)
90	11.37^{f} (0.22)	13.99^{d}_{2} (0.0)	15.20^{c}_{2} (0.10)	15.95^{b}_{2} (0.0)	18.79^{c}_{3} (0.21)	4.71^{f} (0.06)	4.10^{d}_{12} (0.07)	5.00^{c} (0.08)	4.17^{c}_{12} (0.25)	3.62^{c}_{2} (0.06)
120	14.92^{d} (0.01)	18.75^{c}_{2} (0.0)	19.09^{d}_{2} (1.71)	28.80^{c}_{3} (0.61)	-	3.67^{f} (0.20)	4.07^{d} (0.20)	4.18^{d} (0.04)	4.10^{f} (0.07)	-
150	18.73^{e} (0.0)	20.50^{f} (0.0)	22.84^{e}_{2} (0.31)	27.53^{c}_{3} (0.0)	-	4.00^{f} (0.02)	3.93^{d} (0.20)	3.88^{d} (0.09)	3.82^{f} (0.30)	-
180	20.11^{e} (0.0)	-	-	-	-	3.92^{c} (0.05)	-	-	-	-

* Values are the mean of minimum three estimates; - : Not determined, spoiled; standard deviations are indicated in parentheses; Means followed by the same superscript within a column do not differ significantly (P>0.05); Means followed by the same subscript within a row do not differ significantly (P>0.05).

tein surfaces to create a hydrophobic environment, thus resulting in lower extractability. The existence of a significant ($P<0.01$) negative correlation between FFA and SSP in F_1 , F_2 and F_3 further explains this phenomenom.

The sensory attribute 'flavor' of fish mince deteriorated during storage (Fig. 2). The decrease in flavor scores was more prominent in fish held on ice prior to mincing and freezing than in mince prepared from fresh fish. The decrease in solubility of myofibrillar proteins might have caused the low flavor scores, and the product also had a tough, rubbery texture. Typical off-flavor characteristics (bitter) were substantiated by the significant negative correlation between FFA and flavor scores (F_1 - F_5 , $P<0.001$). Accumulation of FFA is said to contribute to the off-flavor of the product and damage texture by complexing with muscle proteins (Mai and Kinsella 1980). Significant negative correlations between TBA number and flavor scores (F_1 , F_2 , F_4 ; $P<0.01$: F_3 , F_5 ; $P<0.05$) suggest that malonaldehyde may be responsible for the rancid flavor. On the contrary, PV was significantly related to flavor in sample F_1 only.

Results of this investigation indicate that the determination of TBA, FFA and SSP are useful for assessing the quality of frozen-stored pink perch mince. On correlating the mean panel scores for flavor of the product, with storage

period (Fig. 2), sample F_1 (fresh) was rated 'acceptable' for 138 days. Samples F_2, F_3, F_4 and F_5 were 'acceptable' for 120, 86, 62 and 7 d, respectively. From the above results, we can conclude that mince obtained from fish held on ice for 3 days can be stored at -18°C for 4-4.5 months without much loss in quality. This can be inferred from the fact that there was no significant difference ($P>0.05$) between the shelf-life or mince obtained from fresh and 3-days ice-stored samples of pink perch.

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References

Bligh, E.G. and W.J. Dyer. 1959. A rapid method for total lipid extraction and purification. Canadian Journal of Biochemistry and Physiology 37: 911-917.

Gornall, A.G., C.J. Bardawill and M.M. David. 1949. Determination of serum proteins by means of the biuret reaction. Journal of Biological Chemistry 177: 751-766.

Jacobs, M.B. 1958. The chemical analysis of foods and food products. Kriegar Publishing Co., Inc., New York.

Joseph, J., C. George and P.A. Perigreen. 1989. Studies on minced fish storage and quality improvement. Journal of Marine Biological Association of India 31: 247-251.

Kussi, T., O.E. Nikkila and K. Sarolainen. 1975. Formation of malonaldehyde in frozen Baltic herring and its influence on changes in protein. Zeitschrift fur Lebensmittel-Untersuchung und-Forschung 159: 285-290.

Mai, J. and J.E. Kinsella. 1980. Composition of lipids and proteins of deboned minced and filleted white sucker (*Catostomus commersoni*). Journal of Food Biochemistry 3: 229-239.

Perez-Villarreal, B. and P. Howgate. 1991. Deterioration of European hake (*Merluccius merluccius*) during frozen storage. Journal of Science of Food and Agriculture 55: 455-470.

Sikorski, Z., J. Olley and S. Kostuch. 1976. Protein changes in frozen fish. CRC Critical Reviews of Food Science and Nutrition 8: 97-129.

Srikar, L.N., H.S. Seshadari and A.A. Fazal. 1989. Changes in lipids and proteins of marine cat fish (*Tachysurus dussumieri*) during frozen storage. International Journal of Food Science and Technology 24: 653-658.

Takagi, T., K. Hayashi and Y. Itabashi. 1984. Toxic effect of free unsaturated fatty acids in mouse assay of diarrulutic shell fish toxin by intra peritoneal injection. Bulletin. Japanese Society of Scientific Fisheries 50: 1413-1418.

Tarladgis, B.G., B.M. Watts, M.Y. Younathan and L. Dugan. 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. Journal of the American Oil Chemists Society 37:44-48.

Vidya Sagar Reddy, G. and L.N. Srikar. 1991. Preprocessing ice storage effects on functional properties of fish mince protein. Journal of Food Science 56: 965-968.

Webb, N.B., E.R. Hardy, G.G. Giddings and A.J. Howell. 1976. Influence of mechanical separation upon proximate composition, functional properties and textural characteristics of frozen Atlantic croaker muscle tissue. Journal of Food Science 41: 1277-1281.

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