# Effect of Pre-processing Iced Storage on Deteriorative Changes in Lipids of Silver Pomfret Stored at -18°C

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Silver pomfret *(Pampus argenteus)* was frozen in the fresh condition as well as after holding in ice for one, two and four days. Evaluation of changes in the quality of these samples during storage at – 18°C has shown that shelf-life decreased sharply if the pre-freezing iced storage was more than one day. The shelf-life of one day iced, two day iced and four day iced frozen samples were 32, 20 and 16 weeks respectively. No correlation was observed between the peroxide value and the organoleptic detection of rancid flavour. Levels of free fatty acids were more in the samples frozen after storage in ice for one day than in all the other samples.

Frozen silver pomfret *(Pampus argenteus)* is an important item of export from Gujarat. Some aspects of the quality of silver pomfret during storage in ice (Kamasastri *et al.*, 1967 a; Venkataraman *et al.*, 1967) and storage under frozen condition (Kamasastri *et al.*, 1967 b) have already been studied. Under commercial conditions the fish used for freezing may not be of uniform quality. It is common practice that due to various reasons fish meant for freezing is kept in ice for varying lengths of time by either the traders or the processors. Although, it is generally known that delay in freezing yields inferior quality products, there is no precise information at present as to what extent such practices affect the quality and shelf-life of frozen pomfrets. A detailed study of this aspect, with special emphasis on deteriorative changes in lipids, was undertaken and the results are presented in this communication.

## Materials and Methods

Fresh pomfrets (uniced on board) of almost uniform size, were collected from the landing centre and brought to the laboratory in iced condition in about 2–3 h. Twelve fishes selected at random were washed, dipped in chlorinated water (10 ppm) and packed in polythene bags, as done commercially. The fish were frozen at -40°C in a contact plate freezer and stored at -18°C. Three other lots were similarly frozen after storage in ice for one, two and four days respectively and stored as above. Samples were drawn periodically for assessment of organoleptic and biochemical changes.

Organoleptic assessment was done after cooking the thawed samples in 2% brine. An experienced panel consisting of three members recorded their rating for colour and appearance, texture, flavour and overall acceptability.

All biochemical analyses were carried out on thawed muscle. Moisture, peroxide value, free fatty acids and iodine value were determined by AOAC (1975) methods. Lipid extraction was done with chloroform-methanol mixture (Bligh and Dyer, 1959). Lipid phosphorus was determined by the method of Fiske and Subbarow (1925) and phospholipid content was calculated by multiplying the phosphorus content with the factor 25.

## Results and Discussion

Changes in biochemical and organoleptic qualities of pomfret frozen without any iced storage and kept at – 18°C are given in Table 1. It was in good and acceptable condition after 32 weeks (Table 2). Moisture level decreased by about 6% during this period. This may be mainly due to loss of moisture through thaw drip. Changes in biochemical parameters like increase in

**Table 1.** *Biochemical changes and overall acceptability of frozen pomfrets stored at* -18°C

| | Storage (period (weeks) | | | | |
|---|---|---|---|---|---|
| | Fresh (0) | 4 | 16 | 20 | 28 | 32 |
| Moisture (% of thawed muscle) | 77.56 | 79.08 | 82.54 | 71.63 | 72.82 | — |
| Free fatty acid (mg/100 g thawed muscle) | 98 | 191 | 248 | 300 | 710 | — |
| Phospholipid (% of thawed muscle) | 0.59 | 0.56 | — | 0.51 | 0.49 | — |
| Peroxide value (m. eq. /kg fat) | 3.3 | 2.5 | 6.1 | 10.3 | 12.5 | — |
| Iodine value | 134 | 103 | 118 | 100 | 101 | — |
| Overall acceptability | Excellent | Very good | Good | Good | Fair | Fair |

**Table 2.** *Organoleptic evaluation of frozen pomfrets stored at* -18°C

| Pre-freezing ice storage (days) | Storage at -18°C (weeks) | Colour/* appearance | Texture* | Odour* | Total | Overall acceptability |
|---|---|---|---|---|---|---|
| 0 | 0 | 5 | 5 | 5 | 15 | Excellant |
| | 4 | 4 | 5 | 5 | 14 | Very good |
| | 16 | 3 | 3 | 4 | 10 | Good |
| | 20 | 3 | 3 | 4 | 10 | Good |
| | 28 | 3 | 2 | 3 | 8 | Fair |
| | 32 | 3 | 2 | 3 | 8 | Fair |
| 1 | 0 | 5 | 5 | 5 | 15 | Excellant |
| | 4 | 4 | 4 | 4 | 12 | Good |
| | 16 | 3 | 3 | 3 | 9 | Good |
| | 20 | 3 | 3 | 2 | 8 | Fair |
| | 28 | — | — | — | — | — |
| | 32 | 3 | 2 | 1 | 6 | Fair |
| 2 | 0 | 4 | 4 | 4 | 12 | Good |
| | 4 | 4 | 4 | 4 | 12 | Good |
| | 16 | 2 | 3 | 2 | 7 | Fair |
| | 20 | 2 | 2 | 1 | 5 | Fair |
| | 28 | — | — | — | — | — |
| | 32 | 1 | 2 | 1 | 4 | Not acceptable |
| 4 | 0 | 4 | 4 | 4 | 12 | Good |
| | 4 | 4 | 3 | 4 | 12 | Good |
| | 16 | 2 | 2 | 2 | 6 | Fair |
| | 20 | 1 | 2 | 1 | 4 | Not acceptable |
| | 28 | — | — | — | — | — |
| | 32 | 1 | 1 | 1 | 3 | Not acceptable |

* Numerical scores were given based on the following scales

| Colour/appearance | | Texture | | Odour | |
|---|---|---|---|---|---|
| Characteristic | 5 | Firm | 5 | Natural | 5 |
| Slightly dull | 4 | Loss of characteristic texture | 4 | Slight loss | 4 |
| Dull | 3 | Slightly soft | 3 | Loss of natural odour | 3 |
| Dull, slight-discolouration | 2 | Soft | 2 | Slightly rancid | 2 |
| Yellow discolour | 1 | Very soft | 1 | Rancid | 1 |

peroxide value, phospholipid hydrolysis and free fatty acid accumulation were similar to the pattern found in many other fishes under similar conditions. Peroxide value showed an increase after an initial induction period of about 4 weeks. Similar trend had been observed in several other instances (Ke *et al.*, 1977; Deng, 1978). Phospholipid hydrolysis and consequent increase in free fatty acids in the muscle were similar to the pattern reported for oil sardine (Viswanathan Nair *et al.*, 1978). About 80% of the phospholipids remained unhydrolysed after a period of 32 weeks. Iodine value of the lipids decreased from an initial value of 134 to 107 during this period. An approximate estimate of the loss of polyunsaturated fatty acids, based on the iodine values (Ackman, 1966) showed that there was a loss of about 50%. This is of high significance from organoleptic as well as nutritional point of view.

Comparison of organoleptic and biochemical characteristics of freshly frozen pomfret with those frozen after storage in ice for varying periods showed that any delay in freezing will adversely affect shelf-life of the product. Although this was only on the expected lines, the significant point was the sharp fall in shelf-life for the samples which were stored in ice for more than one day prior to freezing. Organoleptic assessment of the various samples are presented in Table 2. Overall rating of 'fair' was taken as the limit of edibility, beyond which it was considered unacceptable. One day iced sample reached the limit of acceptability after 32 weeks of frozen storage, while two day iced sample reached this stage by the 20th week of storage and the four day iced sample, by the 16th week.

Loss of characteristic odour and development of rancid flavour appeared to be the limiting factors in overall acceptibility. There was no correlation between development of rancidity and peroxide values. It can be seen from fig. 1 that PV increased progressively during frozen storage at -18°C in all samples. The rate was much higher in the samples held in ice prior to freezing compared to the freshly frozen samples. Slight rancid flavour developed in the freshly frozen samples after 32 weeks. Peroxide value reached comparable levels by the 12th week in the fish with one day pre-freezing iced storage, but perceptible rancid flavour appeared by the 20th week only. The unacceptable off-flavours, described as rancidity, develops as a result of many different mechanisms operating in fish muscle and a measure of lipid oxidation alone will not give a correct indication of the degree of development of these off flavours (Ke *et al.*, 1976).

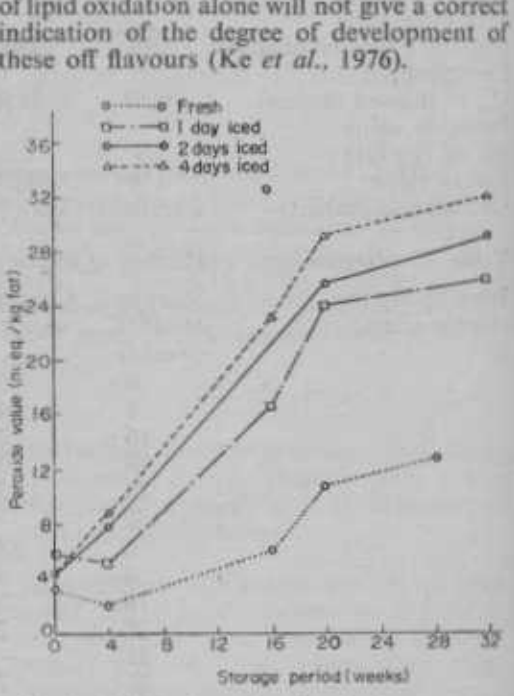


Fig. 1. Effect of pre-freezing iced storage on peroxide value

Rate of formation of peroxide in the iced and frozen samples was higher than that in freshly frozen sample. There was an increase in PV during iced storage (Fig. 1). When the initial oxidation has set in, the quality of fish deteriorates very rapidly and prevention of development of rancidity, after the lipid oxidation proceeded beyond the period of initial induction, is almost impractical (Ke *et al.*, 1977).

Free fatty acid development during frozen storage of fresh and iced pomfret showed an unusual pattern. Fig. 2 shows the accumulation of free fatty acids in the muscle of frozen stored pomfret. It can be seen that the level of free fatty acids was higher in the fish with one day pre-freezing iced storage than in the freshly frozen one. Fish which were frozen after holding in ice for two days and four days had lower levels of free fatty acids than that held in ice for one day. Deng (1978) found that frozen mullet with

7 days pre-freezing iced storage had higher free fatty acids than that with one day iced storage. Hiltz *et al.* (1976) did not find any difference in the levels of free fatty acids production in frozen hake as a result of pre-freezing iced storage for varying lengths of time. In the present case there was a significant reduction in the level of phospholipids after the first day of storage in ice (Fig. 3). This initial low level of phospholipids might have contributed to the subsequent lower levels of free fatty acids in these samples. But the initial free fatty acid levels in the two day and four day iced stored samples were not high enough to account for the observed lower levels of phospholipids. It appears that free fatty acids formed during this stage was lost by some mechanism.

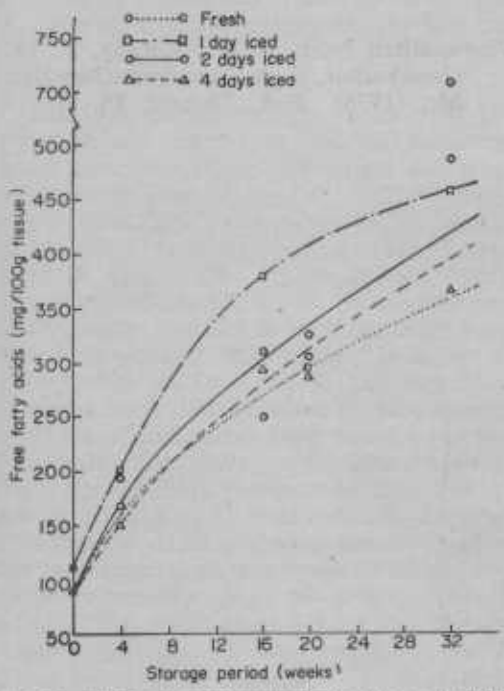


Fig. 2. Effect of pre-freezing iced storage on FFA production

Deng (1978) reported that there was a decrease in the level of free fatty acids after nine months in frozen mullet with one day and 7 days pre-freezing iced storage, which was attributed to increased interaction between free fatty acids and protein molecules. The decrease was sharper in sample with seven days iced storage than that with one day iced storage. Fish muscle had been found to absorb several fatty acids irreversibly at subzero temperatures (Ackman, 1967). The apparent lower levels of free fatty acids production in the samples with two days and four days pre-freezing iced storage, observed during this study, therefore may be due to the irreversible binding of the free fatty acids with the protein or due to oxidative degradation caused by iced storage.

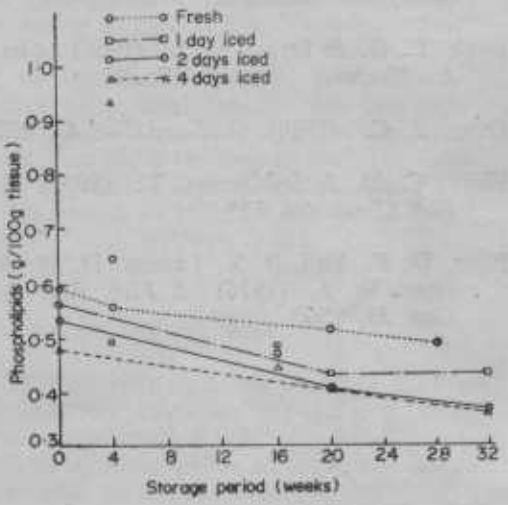


Fig. 3. Effect of pre-freezing iced storage on phospholipid hydrolysis

In order to get a product of reasonably long shelf-life, the maximum duration of pre-freezing iced storage of silver pomfret of about 5% lipids is one day. Any further delay in freezing will reduce the shelf-life drastically. Increase in peroxide value was highly accelerated due to pre-freezing iced storage but decrease in organoleptic acceptability was not directly proportional to the increase in peroxide value. Increase in the levels of free fatty acids was lower in the fish with two days and four days pre-freezing iced storages compared with that with one day iced storage.

The authors are thankful to Shri M. R. Nair, Director, Central Institute of Fisheries Technology, Cochin for his kind permission to publish the paper. Thanks are also due to Dr. K. Gopakumar, Joint Director, CIFT, for critically going through the manuscript and offering valuable suggestions. The assistance rendered by the technical staff of this laboratory is acknowledged.

**References**

Ackman, R. G. (1966) *J. Am. Oil Chem. Soc.* **43**, 385

Ackman, R. G. (1967) *J. Food Technol.* **2**, 169

AOAC (1975) *Official Methods of Analysis*, 12th edn. Association of Official Analytical Chemists, Washington

Bligh, E. G. & Dyer, W. J. (1959) *Can. J. Biochem. Physiol.* **37**, 911

Deng, J. C. (1978) *J. Food Sci.* **43**, 337

Fiske, C. H. & Subbarow, Y. (1925) *J. Biol. Chem.* **66**, 375

Hiltz, D. F., Lall, B. S., Lemon, D. W. & Dyer, W. J. (1976) *J. Fish. Res. Bd Can.* **33**, 2560

Kamassastri, P. V., Sadanand, V. G. & Rao, D. R. (1967a) *Fish. Technol.* **4**, 71

Kamasastri, P. V., Doke, S. N. & Rao,, D.R. (1967b) *Fish. Technol.* **4**, 78

Ke, R. J., Nash, D. M. & Ackman, R. G. (1976) *J. Inst. Can. Sci. Technol. Aliment*, **9**, 135

Ke, P. J., Ackman, R. G., Linke, B. A. & Nash, D. M. (1977) *J. Food Technol.* **12**, 37

Venkataraman, R., Prabhu, P. V. & Mankad, D. J. (1967) IPFC 12th Session, 68/8, IPFC/C66/Tech., 38.

Viswanathan Nair, P. G., Antony, P. D., Gopakumar, K. & Rajendranathan Nair M. (1978) *Fish. Technol.* **15**, 81