FREEZING CHARACTERISTICS OF TROPICAL FISHES
I. INDIAN OIL SARDINE

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The influence of different prefreezing ice storage periods on the biochemical and organoleptic qualities of Indian oil sardines *(Sardinella longiceps)* in the individual quick frozen (IQF) and block frozen (BF) forms and frozen storage at temperatures of—12°C and—23°C was studied. The shelf-life of the sardines varied between 24 and 2 weeks for samples iced for 0 to 5 days prior to freezing. The deterioration in quality was accompanied by considerable increase in the peroxide value (PV) and free fatty acid (FFA) content and decrease in salt extractability of the proteins. These changes were more rapid at—12°C than at—23°C. BF sardines appeared to be better than IQF samples with respect to the biochemical changes although the differences in overall organoleptic quality were not significant.

INTRODUCTION

Although oil sardine is the largest fishery in India averaging an annual catch of approximately 2.5 lakh tonnes, it has not so far been utilized for commercial freezing in the country. Besides economic factors, lack of precise technological data on the amenability of the fish to freezing and frozen storage has been responsible for this condition. Major portion of the catch of the fish is at present utilized for the preparation of sardine oil and sardine guano and a small portion for canning. During the peak season of catch huge quantities are landed and for lack of facility for preservation by freezing or some other way of processing, the fish is even utilized as manure.

The fish, as the name indicates, is oily which becomes rancid quickly. The belly portion is found to be too soft and prone to bursting during ice storage and thawing after freezing. Size is too small and availability too heavy for the individual to be gutted and cleaned as in conventional freezing of fish, which leaves no alternative but to freeze the fish as whole. Though freezing and frozen storage characteristics of oil sardines with particular reference to

rancidity development and its prevention are reported (Vasavan *et al* 1961, Mathen *et al*, 1966) perhaps the data available on the changes of nitrogenous fractions during frozen storage are scanty (Pawar & Magar, 1966).

The present report is part of an exhaustive study on these and related problems and deals with the amenability of the oil sardines to icing and subsequent freezing in IQF and BF forms and with the biochemical changes in the former when stored at —12°C and —23°C.

Materials and Methods

Oil sardines caught by fishing vessels off Cochin were used in these experiments. The sea-fresh graded fish were washed thoroughly with water and stored in ice for 5 days, freezing being carried out at regular intervals as IQF and BF forms. The blocks were prepared with distilled water as glaze. The IQF sardines were given a thin glaze by dipping the frozen samples in ice cold water 2 or 3 times. The samples were then wrapped in polythene paper and stored at—23°C. A separate lot of fresh sardines were similarly frozen individually, divided into two sets, one set was stored at—12°C and the other at —23°C. Analyses of the frozen samples were carried out at regular intervals. The frozen samples were thawed at 4°C for 18 hrs. and the skin and bone free muscle was analysed. Moisture and total nitrogen (TN) were determined by A.O.A.C. (1960) methods. Salt soluble nitrogen (SSN) was determined by the method of Dyer (1955), sarcoplasmic nitrogen (SN) by the method of Frederick (1966), free fatty acids (FFA) by the metod of Dyer and Morton (1956) with the chloroform extract of the tissue in presence of anhydrous sodium sulphate and expressed as % of oleic acid. Peroxide value was also determined with the same chloroform extract and expressed as millimoles/gram of fat. Odour and flavour of the material were evaluated on the thawed sample after cooking for 15 minutes in boiling 3% sodium chloride solution.

Results and Discussion

The biochemical and organoleptic changes in sardines during ice storage are shown in Table I. The changes in the SSN during the frozen storage are shown in figure 1, SN in figure 2, PV in figure 3, and FFA in figure 4. The biochemical changes in sardines stored at –23°C are represented in Table 2 and in those stored at – 12°C in Table 3. Figure 5 summarises the relationship between ice storage and subsequent frozen storage periods based on physical, chemical and organoleptie characteristics.

Analysis during ice storage showed that TN, SSN and SN decreased with increasing period of storage. PV increased at a rapid rate while FFA development was slower. Moisture content increased gradually during storage. The decrease in nitrogenous constituents may be attributed to leaching of soluble constituents by the melting ice. Organoleptic assessment shows that the samples are acceptable only upto 3 days of storage in ice.

In IQF sardines the changes in PV and FFA are higher than in BF sardines which may probably be due to its more exposed surface. In both IQF and BF samples an inverse relationship was found to exist between the development of peroxides and the number of days of ice storage of the sardines prior to freezing. PV and FFA content progressively increased during the 25 weeks of frozen storage.

The salt solubility of the proteins decreased more rapidly in IQF sardines as compared to the BF sardines which may be due to the protective effect of the glaze In the latter case (Pawar & Mager, *loc cit,*). In all the samples the fall in SSN was more pronounced in the initial stages of storage

TABLE I BIOCHEMICAL CHANGES IN SARDINES DURING ICE STORAGE

Fat content : 19% (DWB)

No. of days of ice storage	Moisture %	TN %	SSN %	SN %	PV	FFA %	Organoleptic rating
0	75.0	3.38	58.0	25.6	3.1	2.0	Good
1	76.6	3.26	57.7	25.4	6.9	3.2	Fair-Good
3	77.2	3.21	54.1	23.8	17.9	5.3	Fair
5	77.6	3.15	51.4	20.9	29.8	5.8	Poor

TABLE II BIOCHEMICAL CHANGES IN SARDINES STORED AT —23°C

Fat content : 20% (DWB)

Weeks of storage	Moisture %	TN %	SSN %	PV %	FFA %
0	74.7	3.02	53.1	10.2	2.0
1	72.3	3.06	51.5	15.0	6.8
4	71.3	3.04	49.4	21.9	5 6
8	72.4	2 94	47.9	20.7	6.9
16	71.7	2.95	43.9	38.2	6.4
24	71.6	2.98	42.8	110.8	12.1

TABLE III BIOCHEMICAL CHANGES IN SARDINES STORED AT —12°C

Weeks of storage	Moisture %	TN %	SSN %	PV %	FFA %
0	74.7	3.02	53.1	10.2	2.0
1	72.2	3.04	50.8	15.9	7.6
4	72.3	2.93	50.6	19.6	9.7
8	69.4	3.06	40.7	30.8	13.0
16	70.8	3.03	34.8	43.6	16.3
24	70.9	2.92	36.9	187.7	21.6

and the same was slightly more in the samples stored in ice for longer periods prior to freezing. A close relationship was observed between the development of FFA and SSN as is evident from figs. 1 and 4. Similar results were reported in frozen cod (Dyer and Fraser, 1959). No significant decrease was observed in the SN content in all the samples and no difference could be seen in the changes of this protein fraction between the IQF and BF samples.

A decrease in the moisture content was observed during frozen storage in both the samples which may be due to desiccation. The levels of moisture were slightly higher for the BF sardines than the IQF, probably due to the higher desiccation of the latter resulting in high drip loss and high rate of protein denaturation.

Influence of Frozen Storage Temperature on the changes in quality in oil sardines.

A comparative study of frozen storage of sardines at -12°C and-23°C revealed the rate of development of PV and FFA to be higher in samples stored at -12°C than at -23°C. It is reported by Dyer and Fraser (*loc cit*) that lipid hydrolysis with formation of FFA occurs rapidly in frozen cod fillets stored at -12°C than at -23°C and that when appreciable lipid hydrolysis occurs on storage usually the actomyosin extractability as well as taste panel scores decrease. Similarly the rate of denaturation is more in samples stored at -12°C than at -23°C. This may probably be related to the development of FFA in the samples stored at -12°C. Very low temperature may be effective in retarding the oxidative and hydrolytic changes in frozen sardines, but temperatures below -23°C have not been tried in these studies.

The decrease in moisture contens were more pronounced in samples stored at -12°C than at -23°C. From the results of organoleptic assessment it was observed that the maximum storage life of oil sardines in ice was 3 days and that there

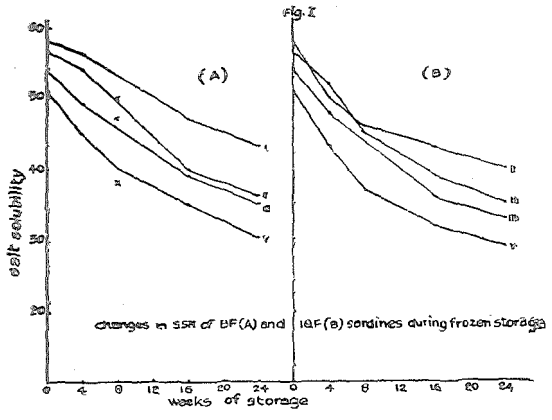

Fig 1.

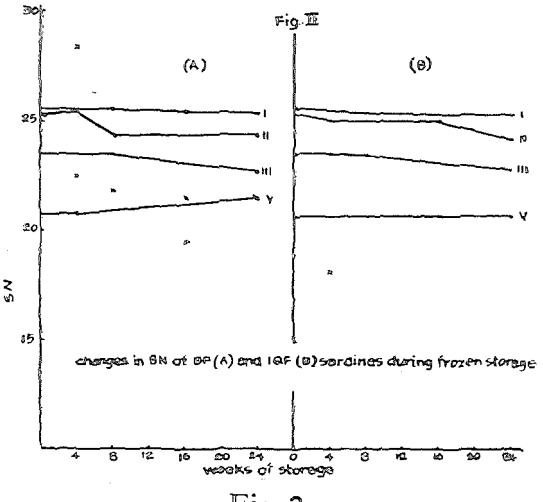

Fig 2.

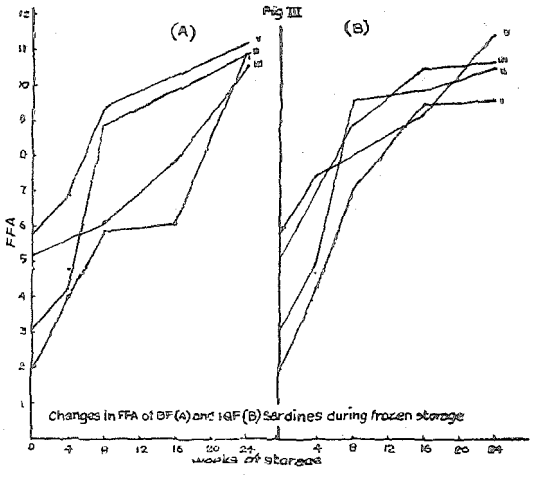

Fig 3.

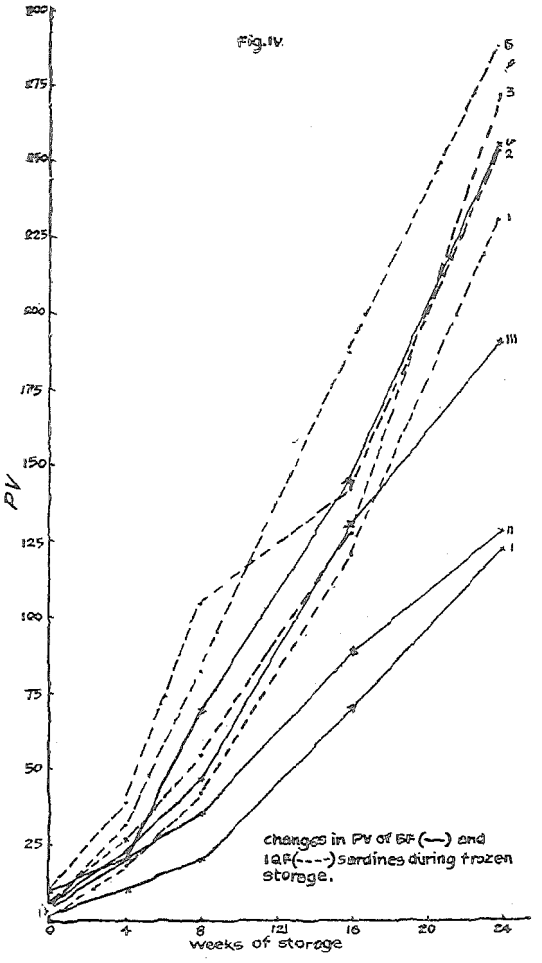

Fig 4.

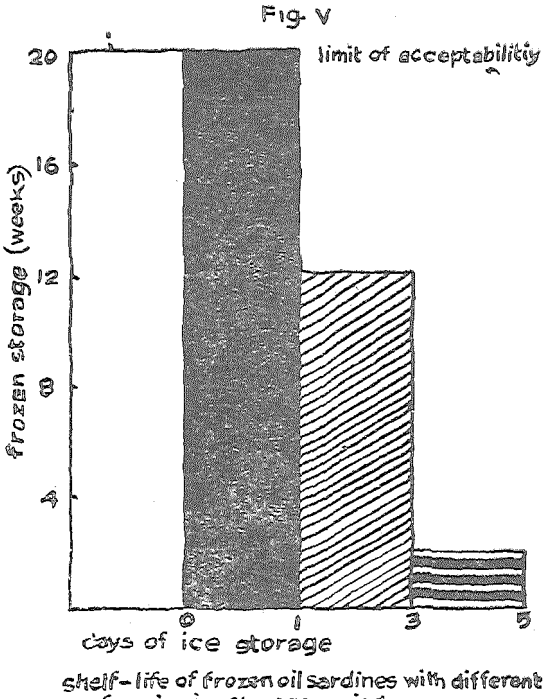

Fig 5.

was an inverse relationship between the period of pre-freezing ice storage and frozen storage shelf life, which was 20 weeks for fresh uniced samples and 2 weeks for samples iced for 5 days prior to freezing. No significant difference in the organoleptic quality was observed between the BF and IQF samples during storage. In sardines stored at -12°C rancid odour and flavour were perceptible much earlier than in those at -23°C.

Conclusions

(1) There is no significant difference in either the organoleptic or biochemical characteristics between IQF and BF sardines. However from the point of view of economics of operation it may be advantageous to resort to freezing in IQF form.

(2) Oil sardines lose their acceptability and shelf life if the pre-freezing ice storage is for more than 3 days.

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