STUDIES ON PRESERVATION OF FISH IN REFRIGERATED SEA-WATER

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Storage characteristics of oil sardine *(Sardinella longiceps)*, mackerel *(Rastrelliger kanagurta)* and seer *(Scomberomorus guttatus)* in refrigerated sea-water (RSW) were studied in comparison with their storage in crushed ice. Oil sardine stored in RSW was found to be comparable to iced ones only during the initial stages (upto 2 days) of storage and on further storage the former was found to be inferior to the latter. RSW can be advantageously employed for preservation of mackerel and seer. Mackerel and seer could be stored in RSW in acceptable condition for 4 to 6 days and 12 to 14 days respectively.

INTRODUCTION

Lantz (1956) preserved his fish catch in refrigerated sea-water (RSW) on board the exploratory vessel "Canadian North Sea Star" and landed the same in excellent condition after 3 days fetching a much higher price than the catch preserved in ice for a similar period. He further observed that the cost of operation of refrigeration equipment was negligible compared to cost of icing, the fish stored in chilled brine required minimum of handling and the fish upon removal from the tanks had the appearance and other characteristics of freshly caught fish. The various advantages of using RSW for preserving fish on board fishing vessels as well as on-shore establishments have been elaborately dealt with by Roach *et al.*(1961). Mihajlova (1961) achieved better fish quality in RSW due to acceleration of the cooling process at optimum storage temperature of -2 to -3°C and observed that the increase in salt content was not more than by 0.3% from the initial 0.5% which did not affect the fish quality. Sensory evaluation of raw and cooked ocean perch indicated a marked preference for fish stored in RSW over that held in ice, the former remaining in edible quality for 7 days longer than the latter (Cohen and Peters, 1962). The same authors (1963) observed that RSW maintained at -1.1°C extended chilled storage life of whiting by 2 to 3 days than when held in ice and that organoleptically the

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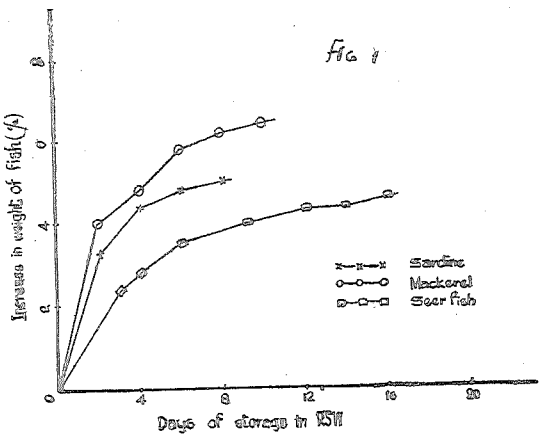

Fig. 1

RSW stored fish were better than ice stored fish. Various aspects of the problems involved in chilling and freezing of salmon and tuna in RSW have been elaborated by Roach *et al.* (1967).

Oil sardine (*Sardinella longiceps*), mackerel (*Rastrelliger kanagurta*) and seer (*Scomberomorus guttatus*) are three of the commercially important food fishes and priority was given to these fishes in our programme of application of this method of preservation. Salient features of studies carried out on these varieties of fishes with regard to their amenability to this method of preservation are summarised in this communication.

Materials And Methods.

The equipment used was the one described by Pillai (1974). Artificial sea-water was prepared by dissolving common salt in potable water to give a sodium chloride content of 3.5%. It was cooled below -1°C and the fishes were stored in this and the temperature maintined at -1.1 to 0°C. The ratio of fish to sea water was 2:1.

Oil sardine and mackerel used for the study were procured from the Integrated Fisheries Project as well as from country crafts operating off Manaseri near Cochin and seer from the Institute's boats. Absolutely fresh materials were brought to the laboratory, washed in potable water and stored separately in RSW maintained at -1.1°C and in crushed ice. Sardine had an average weight of 25 to 40g., mackerel 90 to 100g. and seer 3 to 3.5kg. Samples were withdrawn at specific intervals and changes in physical, chemical, bacteriological and organoleptic characteristics were followed. The changes in weight of the fish were determined after allowing the fish to drain for 5 minutes. The salt

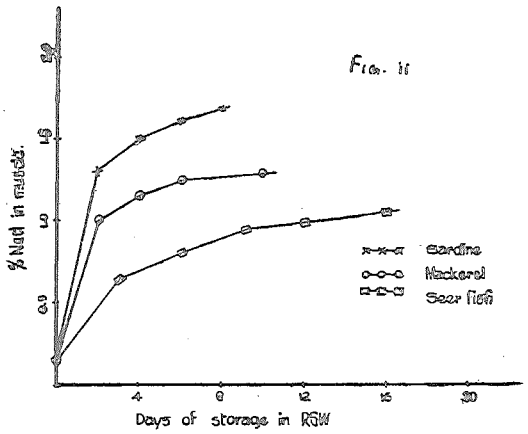

Fig. 2

absorption was measured by the A.O.A.C. (1960) methods. The peroxide value (PV) and free fatty acids(FFA) were determined by the methods of Lea (1952) and A.O.C.S. (1946), respectively. The samples for bacteriological analysis were taken under aseptic conditions. The muscle with skin was cut from either sides of the fish and about 10g. were used for determination of the total viable plate count by using sea-water agar as the plating medium

TABLE I

Changes in peroxide value (PV), free fatty acids (FFA), total bacterial count and organoleptic characteristics of oil sardine stored in crushed ice (I) and in RSW (II)

Average weight of sardine — 32 gm.
Fat content (DWB) — 25.60 %

Days of Storage	PV (ml. N/500 thio-sulphate per gm. fat)		FFA (as Oleic acid %)		Total bacterial count per gm.		Organoleptic Characteristics	
	I	II	I	II	I	II	I	II
0	2.88	2.88	1.82	1.82	8.05×10^3	8.05×10^3	Good, belly-bursting - Nil	Good, Belly-bursting - Nil
1	3.08	6.10	2.01	1.74	1.15×10^5	1.06×10^4	Fair to good, belly-bursting 16%	Fair to good, belly-bursting 6% Firm texture.
2	4.12	5.60	2.81	4.40	7.3×10^4	8.3×10^4	Fair, belly-bursting 43%	Fair, belly-bursting 11%, Discolouration of flesh near main bone.
4	10.84	17.74	4.66	5.46	4.3×10^6	3.5×10^6	Fair, belly-bursting 55%	Fair to poor, belly-bursting 22%, Rancid flavour, Discolouration of flesh near main bone.
6	23.02	34.72	5.04	5.87	3.2×10^6	3.8×10^6	Poor, Rancid	Poor, Highly rancid.

TABLE II

Changes in peroxide value (PV), free fatty acids (FFA), total bacterial count and organoleptic characteristics of mackerel stored in ice (I) and in RSW (II).

Average weight of mackerel - 90 gm. Fat content (DWB) 8.06 %

Days of storage	PV (ml.N/500 thio-sulphate per gm. fat)		FFA (as Oleic acid %)		Total bacterial count per gm.		Organoleptic characteristics	
	I	II	I	II	I	II	I	II
0	1.72	1.72	2.01	2.01	2.95×10^3	2.95×10^3	Good	Good
2	3.94	4.18	1.92	2.01	5.6×10^3	3.5×10^3	Fair to good	Fair to good Firm texture, better appearance.
4	6.16	6.78	3.84	4.50	7.2×10^4	8.59×10^4	Fair	Fair
6	12.80	16.80	4.04	4.32	1.12×10^5	5.78×10^4	Fair	Fair
8	16.00	12.05	6.72	5.81	8.04×10^4	1.31×10^5	Poor	Poor

TABLE III

Changes in peroxide value (PV), free fatty acids (FFA), total bacterial count and organoleptic characteristics of seer fish stored in ice (I) and in RSW (II).

Average weight of seer — 3.0 kg.
Fat content (DWB) — 14.4 %

Days of storage	PV (ml. N/500 thio-sulphate per gm. fat) I	II	FFA (as Oleic acid %) I	II	Total bacterial count per gm. I	II	Organoleptic characteristics I	II
0	1.92	1.92	1.62	1.62	5.30×10^3	5.30×10^3	Good	Good
1	2.16	3.18	2.60	1.93	—	—	Good	Good
3	7.85	7.08	2.44	3.05	1.12×10^4	8.05×10^3	Fair to good	Fair to good
6	6.12	8.04	2.81	2.69	2.82×10^4	3.32×10^4	Fair, slightly soft	Fair to good Firm texture
9	14.98	11.04	4.46	3.44	1.12×10^5	2.90×10^4	-do-	-do-
12	16.12	19.18	3.84	5.56	2.15×10^5	8.06×10^4	Poor, soft texture, off flavour	Fair
14	—	17.62	—	5.17	1.12×10^6	3.30×10^5	—	Fair
16	—	23.88	—	6.31	8.0×10^6	2.55×10^6	—	Poor, off odour, rancid.

(Surendran and Iyer, 1971). The physical and organoleptic characteristics of the raw and cooked fish were also studied at suitable intervals. In addition to the characteristics studied the extent of belly-bursting was determined at intervals in the case of oil sardine.

Results And Discussion

In general, the RSW stored fish had firmer texture and better appearance than ice-stored ones. Steady increase in weight and sodium chloride contents of the fish occurred in all cases during storage in RSW with increasing duration of holding as seen from fig 1 and 2. The changes were more rapid in early days of storage. Seer which is comparatively bigger in size absorbed salt more slowly compared to smaller fishes like sardine and mackerel.

PV in the case of RSW stored oil sardine increased at a more rapid rate than those held in ice (Table I). This may be attributed to the catalytic action of sodium chloride in the oxidation of fats as observed by earlier workers (Castell, *et al.* 1965). Eventhough FFA contents in RSW-held sardine also showed a tendency to increase more rapidly than in ice stored samples the difference was not so striking as in the case of peroxide values. Bacteriologically the RSW and ice stored sardine did not show significant difference, but organoleptically the RSW stored sardine was comparable to iced samples only during the initial stages of storage (upto two days) and after this period the former was judged to be inferior to the latter (Table I). This may be attributed to the faster development of rancidity in RSWstored samples. The flesh near the main bone of RSW stored sardine showed a brownish discolouration after two days' storage. Similar phenomenon has been observed in the case of herring held in RSW by Torry Research Station (Anon, 1969). The incidence of belly-bursting was lower in RSW stored sardine than in ice stored fish.

Mackerel, which had an average fat content of 8% on dry weight basis, stored in RSW was found to be slightly better in quality during intitial stages(up to 2days) of storage, but after this period the spoilage rates of mackerel stored in RSW and in ice were almost similar as seen in Table II. A slight discoloration of flesh near the main bone was noticed after 2 days' storage in RSW in the case of mackerel also (Table II).

The RSW stored seer was found to be superior to ice stored samples (Table III). In RSW whole seer could be stored in acceptable condition for a period of 12 to 14 days.

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