

Studies on Frozen Storage Characteristics of Sole Fish *Cynoglossus macrolepidotus*

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Fresh sole fish (*Cynoglossus macrolepidotus*) was quick frozen at -40°C and stored at -18°C . Shelf life was evaluated by following biochemical, bacteriological and organoleptic changes occurring during storage. Rapid decrease was noted in the water extractable nitrogen and salt soluble nitrogen fractions. Samples of frozen sole fish remained in acceptable condition for 20 weeks.

The average annual landings of sole fish in India is about 12,616 t (1969–1979). Landing of soles in Gujarat ranged from 0.47% (1971) to 29.43% (1976) of total soles landed in India. In Veraval, sole contributes about 3.2% of the total trawl landings.

At present the soles fetch very poor return as the whole catch is utilized for fish meal production. However the recent trade enquires for frozen sole from Spain and Italy, promise a good export potential for this tasty, but under-utilized fish. Utilisation of this fish for freezing would also lead to the diversification of the Indian seafood export. Keeping this in view the present study on freezing and frozen storage characteristics of solefish was carried out.

Materials and Methods

Sole fish with an average weight of 60 g each were procured in fresh condition from the trawl landings at Veraval and brought to the laboratory. The fish after initial washing was beheaded and eviscerated and again washed with freshwater. Four numbers of dressed fish weighing between 175–225 g were packed in polythene bags and quick frozen in a contact plate freezer at -40°C and the frozen product was kept in cold storage at -18°C . The fish muscle was analysed for changes in bacteriological, biochemical, physical and organoleptic characteristics, just before and immediately after freezing and then periodically for a period of 28 weeks. Frozen samples prior to analysis were sealed in polythene bags and thawed in running water at room temperature and the meat from thawed fish was used for analysis.

Moisture was determined by AOAC (1960) methods, total nitrogen (TN), water soluble nitrogen (WSN) and non-protein nitrogen (NPN), by microkjeldhal method; salt soluble nitrogen (SSN) was determined by the method of Dyer *et al.*, (1950); total volatile bases (TVB) were estimated from a TCA extract by microdiffusion method of Conway (1947). Total bacterial count (TBC) was determined by the standard pour-plate method (IS: 2237-1971). The organoleptic tests were carried out on the thawed material after cooking in 3% boiling brine for 5 min.

Results and Discussion

Proximate composition of the fresh fish muscle (Table 1) shows that the sole is a lean fish and contains little higher percentage of moisture than average. The results

Table 1. Proximate composition of the fresh muscle

Moisture, %	80.61
Proteins, % (TN x 6.25)	15.87
Fat, % (WWB)	0.22
Ash, % (WWB)	2.53
Water soluble	448.00
nitrogen, mg/100 g	
Non-protein	192.50
nitrogen, mg/100 g	
Salt soluble	47.87
nitrogen (% of TN)	

of biochemical, bacteriological and organoleptic changes, taking place in sole muscle during frozen storage are presented in Table 2.

Table 2. *Changes in frozen sole fish during storage at -18°C*

Storage period	Moisture %	TN %	WSN mg/100g	NPN mg/100g	SSN % TN	TVB, mg N/100g	Total bacterial count/g	Overall quality
Initial (before freezing)	80.61	2.54	448	192.50	47.87	...	1,40,000	Excellent
After freezing	78.72	2.98	532	218.40	34.36	14	1,31,500	Very good
2 weeks	77.85	3.01	616	262.50	26.04	11.2	71,310	Very good
4 "	78.82	2.65	560	210.00	25.35	10.5	880	Good
6 "	78.67	2.65	504	175.00	26.41	10.5	33,000	Good
8 "	78.44	2.68	504	175.00	25.07	10.5	17,850	Good
12 "	78.09	2.96	476	131.25	21.75	11.2	11,810	Very fair
16 "	78.34	2.72	490	122.50	22.13	11.2	4,500	Very fair
20 "	77.5	2.78	394.8	115.13	21.94	...	2,000	Fair, slightly soft texture
24 "	78.25	2.74	443.7	110.49	20.36	...	943	Fair, dull appearance, soft texture
28 "	78.52	2.67	432.8	118.97	18.65	...	1,000	Poor, very soft texture, dull colour, ragged appearance

The changes in the moisture content of the muscle during frozen storage showed a decreasing trend initially with very little variations on prolonged storage. The TN values did not register any appreciable change during storage. Both WSN and NPN values showed appreciable increase in the early stage, followed by a gradual decrease as the period of storage increased. The SSN value of the initial unfrozen sample showed a very rapid fall just after freezing. The fall in SSN is more pronounced in the first two weeks of storage, followed by a gradual decrease after 8 weeks of storage. This is due to the denaturation of proteins during frozen storage. This fall in SSN values coincided very well with the overall quality of fish at the later stages of storage.

In general, the trend of the biochemical changes taking place during frozen storage of the sole fish followed a similar pattern as observed earlier in the case of sardine, Bombay duck and *Chanos chanos* by Shenoy & Pillai (1971); Radhakrishnan *et al.* (1973) and Jose Joseph *et al.* (1980) respectively.

Shelf-life as shown by the physical and organoleptic evaluation revealed that the fish remained in good condition upto 8 weeks of storage and in a fair and acceptable condition upto 20 weeks of storage without losing much of the original characteristic odour and texture. Thereafter the fish started deteriorating and underwent drastic changes in physical and organoleptic characteristics, leading to a ragged appearance of the cooked muscle. Hence, it is safe to conclude, that the 20th week as the border-line of acceptability.

As expected total bacterial count decreased and did not show any apparent relationship with the overall quality of the fish.

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