

PRESERVATION OF FISH BY FREEZING AND GLAZING:

III. EFFECT OF FREEZING, GLAZING AND FROZEN STORAGE ON THE B-VITAMINS AND ESSENTIAL MINERALS PRESENT IN THE FISH FLESH

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The changes occurring in moisture, thiamine, riboflavin niacin, phosphorus, iron and calcium in pomfrets, surmai and mackerel frozen, glazed with ascorbic acid, citric acid, sodium chloride & glucose and sodium nitrite and kept under frozen storage were studied upto 6 months and results reported.

INTRODUCTION

Nutritionally important components of fish muscle have been exhaustively studied by various scientific workers in India and abroad. However, estimation of nutrients in fish flesh on storage has not been carried out extensively. Preservation of fish in chemical ices and chemical substances is in practice since 1926 (Chen and Fellers, 1926). As far as organoleptic characteristics of fish are concerned freezing is approved to be one of the methods of preservation of fish. Despite this fact, information relating to this aspect is meagre. It is known definitely that freezing causes some mechanical disruption of musculature of fish which can cause loss of nutrients. This suggested a study of the nutrients such as B. vitamins and essential minerals like phosphorus, calcium and iron during frozen storage of the fish.

EXPERIMENTAL

Following three fishes were selected for study: (1) White pomfrets (*Stromateus cine-reus*), (2) Surmai (*Cybbium commersoni*) and (3) Mackerel (*Rastrelliger canagurta*). Pomfret and surmai were quickfrozen and glazed in order to retard the changes which the fish undergoes during prolonged frozen storage (Tressler, 1932). Pomfrets were divided into 4 groups: (1) Control (2) Packed in gunny bag with polythene lining, (3) Ascorbic acid glazed (0.1%) and (4) Sodium chloride and glucose glazed (0.5%). Surmai were also divided into four groups: (1) Control (2) Ascorbic acid glazed (0.1%), (3) Citric acid glazed (1.0%) and (4) Sodium nitrite glazed (1.0%).

Mackerels were block frozen in trays with glazing water. Individually frozen mackerel without glaze was used as control.

White pomfret and surmai were regularly reglazed by spray with respective chemicals at intervals of four weeks. Overall frozen storage period was 4½ months, 5 months and 6 months in the case of white pomfret, surmai and mackerel respectively. Pomfret was sampled first after 1½ months and later at an interval of 1 month. Surmai and mackerels were sampled at intervals of 1 month from the very beginning of the experiment.

1. *Thiamine* was estimated by Jansens' method (1936)
2. *Riboflavin* was estimated by the method of Scott *et al* (1946).
3. *Niacin* was estimated by the method of Sweeny (1951)
4. *Calcium* was estimated by the method of Kramer and Tisdall (1921)
5. *Phosphorus* was estimated by the combination of methods of Bell and Doisy (1920) and Sterges *et al* (1950)
6. *Iron* was determined by the combination of methods of Moss and Mellon (1942) and Hill (1930)
7. Moisture was estimated by drying the moist tissue to perfect dryness.
Results are tabulated in Tables 1 to IV.

RESULTS

Pomfrets

Moisture content decreased rather rapidly in the control group from its initial value of 75% to 66% after three months and then gradually in 4½ months to about 63%. Loss in moisture was less in the groups glazed with sodium chloride-glucose solution during 4½ months of frozen storage followed by ascorbic acid treatment. Gradual loss in B-Vitamins such as thiamine, riboflavin and niacin was noted during storage. Retention of thiamine was nearly 30.00%, 31.54%, 38.11%

and 43.50% in control, gunny bag with polythene, ascorbic acid and sodium chloride-glucose glazed pomfret respectively at the end of 4½ months. Retention of riboflavin was nearly 29.00%, 39.00%, 50.37%, 53.00% in the same order as mentioned above. Retention of niacin was nearly 40.00%, 41.42%, 49.00%, 56.00% as above. In the case of minerals, same trend was observed. However, calcium was noted to be unaffected on storage. Retention of phosphorus was nearly 68.5%, 69.6%, 72.4% and 74.00% and iron 32.15%, 35.72%, 46.43%, 64.30% in the same order of groups as above at the end of the storage period.

Surmai

Moisture content decreased from the initial value of 76.0% to 70.89%, 71.00%, 73.00% and 72.87% in control, ascorbic acid, citric acid and sodium nitrite treatments respectively at the end of 5 months. In glazed fish the loss was less than that in control group. Retention of thiamine at the end of 5 months was nearly 22.00%, 22.00%, 29.00% and 30.00%, that of riboflavin nearly 40.63%, 40.63%, 44.70% and 43.00% and that of niacin 44.00%, 49.00% and 44.00% in the same order of groups as above. As regards minerals such as calcium, phosphorus and iron, calcium was noted to be unaffected by frozen storage. Retention of phosphorus at the end of 5 months was 50.75%, 51.75%, 57.36% and 55.65% and that of iron 14.20%, 27.36%, 79.50% and 28.2% in the same order of groups mentioned above.

Mackerel

Moisture content decreased from 77.7% to 70.00% and 72.00% at the end of 6 months in control and block frozen respectively. Retention of thiamine was nearly 4.50% and 2.45%, that of riboflavin 16.00% and 11.2% and that of niacin 40.00% and 24.00% in control and block frozen mackerels respectively at the end of

TABLE I ANALYSIS OF

Contents	Initial	1½ months					
		I	II	III	IV	I	II
Moisture %	75.24	71.69	74.23	73.81	75.50	69.08	73.80
Thiamine μ g %	23.00	8.26	9.30	12.14	13.13	7.73	8.50
Riboflavin μ g %	1824	1103	1250	1277	1517	1052	1239
Niacin mg %	4.66	2.40	2.50	2.83	3.03	2.26	2.33
Phosphorus %*	1.62	1.22	1.23	1.24	1.25	1.14	1.15
Iron mg %*	14.00	6.27	6.48	8.25	12.00	6.00	6.27
Calcium mg %*	800	800	805	805	810	810	810

I: Control, II. Gunny bag with polythene lining, III; Ascorbic acid, IV: Sodium

TABLE II ANALYSIS OF

Contents :	FRESH	One month					
		I	II	III	IV	I	II
Moisture %	76.8	73.0	73.8	75.8	75.0	71.7	72.6
Thiamine μ g %	20.4	5.6	5.8	6.5	6.5	4.8	5.0
Riboflavin μ g %	895	396	430	439	439	365	401
Niacin mg %	4.1	2.0	2.1	2.5	2.4	1.9	1.9
Phosphorus % *	2.0	1.4	1.4	1.5	1.4	1.4	1.4
Iron mg % *	11.1	5.3	6.1	9.6	8.0	5.2	5.9
Calcium mg % *	510	505	505	515	500	505	500

I: Control II: Ascorbic acid III: Citric acid IV: Sodium nitrite

the frozen storage. Retention of phosphorus was 20.45% and 19.6% and that of iron 25.00% and 12.00% respectively.

DISCUSSION

Decrease in moisture content of fish during storage was due to desiccation, as there was nearly 10-15% difference in R. H. value of the surrounding environment and that of frozen fish. In the glazed fish losses due to desiccation were less because moisture from tissue was not lost till the glaze on fish was evaporated. Dyer and Martin (1956) did not find any change in moisture during frozen storage. But in their experiments fillets were coated with wax and kept in cartons with moss gel which prevented the loss of moisture due to evaporation. Pearson *et al* (1951) have stated that the amount of drip did not appear to be influenced by the rate of

freezing but increased as the period of frozen storage was prolonged. They concluded that there was considerable loss of B-vitamins such as thiamine, riboflavin, niacin, pantothenic acid, folic acid and pyridoxine on frozen storage due to thawing of frozen fish stored for a long period. Similarly drip of fish exuding on thawing was also found to contain B-vitamins and minerals (Sea Secrets, 1957).

In the light of the above mentioned information it may be stated that losses encountered in vitamins and minerals from frozen fish tissue are in the first place, due to various changes that are set in spontaneously by contaminants and then by subsequent freezing and frozen storage over long period (Pearson 1951, 1959, Reay 1949). It is a common practice to freeze fish when the rigor mortis is over.

POMFRETS ON FROZEN STORAGE

2½ months		3½ months				4½ months			
III	IV	I	II	III	IV	I	II	III	IV
72.41	75.26	66.21	73.61	71.67	75.01	63.17	71.39	63.34	74.98
10.21	11.23	7.13	8.12	9.18	10.57	6.92	7.25	8.76	10.00
1263	1495	708	769	973	1239	529	714	819	911
2.60	2.90	2.06	2.16	2.46	2.73	1.86	1.93	2.30	2.60
1.18	1.20	1.11	1.13	1.17	1.19	1.01	1.11	1.15	1.17
8.00	12.00	5.90	6.09	7.70	10.00	4.50	5.00	6.50	9.00
805	805	805	810	800	805	805	805	805	805

chloride and glucose.

* Calculated on dry weight basis.

SURMAI ON FROZEN STORAGE

Two months		Three months				Five months			
III	IV	I	II	III	IV	I	II	III	IV
74.2	74.1	70.8	71.9	73.9	73.9	70.8	71.0	73.0	72.8
6.4	5.6	4.4	4.8	6.1	5.5	4.1	4.4	6.1	5.3
440	414	365	395	418	412	364	364	400	386
2.4	2.4	1.7	1.8	2.1	1.9	1.7	1.8	2.0	1.8
1.5	1.4	1.2	1.3	1.4	1.3	1.0	1.0	1.1	1.1
9.6	7.6	4.0	4.1	9.6	4.3	1.6	3.0	8.8	3.1
505	500	500	505	495	505	506	500	505	500

* Calculated on dry weight basis.

Therefore, pH of flesh at the time of freezing is almost neutral and flesh is softened due to loosening. The drip that is developed during frozen storage and liberated on thawing is nothing but emulsion of various nutrients such as B. vitamins and minerals (Pearson, *loc. cit.*) Sea Secret, *loc. cit.*) As regards calcium which is unaltered during frozen storage, it may be said that it remains there in tissues in insoluble form. Another tenable explanation may be offered on the basis of denaturation of protein (Love, 1958).

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TABLE III ANALYSIS OF MACKEREL ON FROZEN STORAGE

Content	Initial	1 month		2 months		3 months		4 months		6 months	
		I	II	I	II	I	II	I	II	I	II
Moisture %	77.74	74.15	76.59	73.71	76.03	73.18	75.22	72.44	74.36	70.01	72.05
Thiamine μ g %	45.91	25.57	39.79	10.96	12.09	9.80	10.59	8.15	9.80	2.45	4.49
Riboflavin μ g %	1788.0	1296.0	1545.4	369.5	383.5	325.9	373.3	285.8	357.0	200.00	282.8
Niacin mg %	4.0	2.75	2.75	1.07	1.70	1.00	1.62	0.95	1.60	0.95	1.60
Calcium mg %*	610.0	600.0	605.0	605.0	600.0	600.0	600.0	600.0	610.0	600.0	600.0
Phosphorus %*	2.11	1.23	1.39	1.17	1.36	1.07	1.08	0.99	1.03	0.98	1.02
Iron mg %*	11.90	4.76	6.07	4.16	5.59	3.84	5.13	3.45	4.19	1.43	2.97

I: Control II: Block frozen * Calculated on dry wt. basis.

TABLE IV PERCENTAGE RETENTION OF THE NUTRIENTS ON FROZEN STORAGE

Fish and Period	Glaze	Thiamine	Riboflavin	Niacin	Phosphorus	Iron	Calcium
Pomfret 4½ months	Control	30.1	29.0	39.9	62.7	32.2	100
	Ascorbic acid	38.1	50.4	49.4	71.1	46.4	100
	Sodium chloride and glucose	43.5	53.3	55.8	72.4	64.3	100
Surmai 5 months	Control	20.4	40.6	44.0	20.3	14.2	100
	Ascorbic acid	22.0	4.6	44.0	20.5	27.4	100
	Citric acid	30.0	44.7	49.0	22.9	79.5	100
	Sodium nitrite	27.0	43.1	44.0	22.3	28.2	100
Mackerel 6 months	Control	5.3	11.2	24.0	19.6	12.0	100
	Block	9.8	15.8	40.0	20.5	25.0	100

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