

PART II  
SCIENTIFIC AND TECHNICAL  
TECHNOLOGICAL ASPECTS OF PRESERVATION AND  
PROCESSING OF EDIBLE SHELL FISHES

V. COLD STORAGE CHANGES IN MUSSELS (*MYTILUS EDULIS*)  
AND CLAMS (*VILLORTIA SP.*)

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The changes in chemical, bacteriological and organoleptic qualities of mussels and clams during freezing and subsequent frozen storage have been studied in relation to the holding time in ice prior to freezing and the shelf-life of the product is determined.

#### INTRODUCTION

Industry based on processing of mussels and clams has immense possibility to develop in future because of the availability of this highly nutritious raw material. Seasonal variation in quality and supply is an important drawback in the exploitation of these shell fishes. Sebastian (1970) had given an account of the prospects of canning mussels and clams. Ice storage characteristics of these shell fishes have already been reported (Chinnamma *et. al.* 1970); but information regarding the freezing characteristics has been scanty. The present communication summarises the results of investigations taken up in this direction.

#### EXPERIMENTAL PROCEDURE

Mussels (*M. edulis*) obtained from

Calicut were transported to the Laboratory in a refrigerated van and clams (*Villorita sp.*) were collected from a local source. These were kept separately in insulated ice boxes in direct contact with ice and the meat was separated and quick frozen (-40°C), at regular intervals, with the required amount of water as glaze. The frozen material was wrapped properly in order to prevent dehydration losses during further storage and stored at -23°C.

Frozen samples were drawn at intervals, thawed at 4°C for 17 hours, and analysed for moisture, salt soluble protein, free  $\alpha$ -amino nitrogen and inorganic phosphorus in addition to the subjective tests according to the methods given earlier (Chinnamma *et. al.* 1970; and Chinnamma George 1973). Total bacterial count and counts of *Escherichia coli* and *Faecal streptococci* were

TABLE 1 (a)

BIOCHEMICAL CHANGES IN MUSSELS DURING FREEZING AND STORAGE AT(-23°C).

Frozen Storage Weeks	Pre-Process ice storage days	Moisture %				Salt soluble protein as % of total protein				Free $\alpha$ -NH <sub>2</sub> -N. mg%.				Inorganic phosphate (mg. P %)			
		→ 0	2	6	8	0	2	6	8	0	2	6	8	0	2	6	8
Raw material		79.0	77.9	78.1	77.8	64.3	62.5	60.6	58.0	117.6	117.6	109.2	92.4	20.3	21.5	17.2	16.8
2		76.0	75.3	76.1	76.0	62.5	54.0	53.0	53.0	95.2	95.2	86.8	84.0	22.6	23.4	20.8	23.8
12		76.6	75.5	76.0	76.5	60.6	54.8	48.7	52.2	86.8	95.2	81.2	78.4	27.9	27.1	32.5	29.5
22		74.8	74.2	75.9	75.4	58.0	53.1	49.9	49.9	84.0	92.4	78.4	72.8	30.7	30.7	31.6	31.6
32		73.9	74.3	75.7	75.1	56.0	44.8	46.2	46.3	84.0	92.4	75.4	70.0	33.1	32.6	31.1	31.5
44		73.9	73.4	75.9	75.1	52.2	46.2	43.2	45.2	86.8	90.8	72.8	70.0	34.9	33.9	34.7	34.4

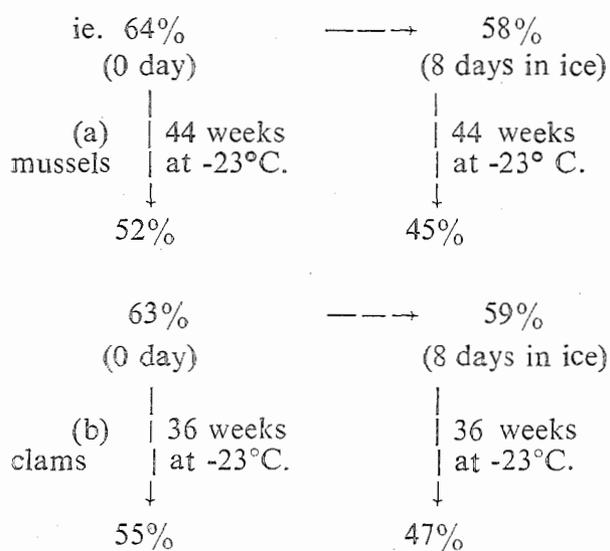
## DRIP CONSTITUENTS

Frozen storage weeks	Pre-process ice storage days	Drip volume ml.				Free $\alpha$ -NH <sub>2</sub> -N. mg%				Inorganic phosphate (mg P %)			
		→ 0	2	6	8	0	2	6	8	0	2	6	8
2		28.4	31.2	40.4	41.7	28.3	29.7	32.4	30.0	3.0	2.8	4.0	3.8
12		34.4	36.7	40.3	41.5	36.1	35.2	41.9	34.0	8.0	7.1	10.2	10.7
22		36.4	40.1	41.5	42.1	44.1	36.1	40.9	34.2	12.0	9.5	15.0	13.2
32		36.9	39.7	42.1	43.9	37.7	36.8	36.0	33.1	11.0	9.6	13.5	14.2
44		39.2	41.5	45.8	48.7	48.7	39.5	37.8	36.1	13.3	11.8	16.4	16.4

determined by the methods given in I. S. I. Specification for frozen prawns. (I. S.; 2237 - 1962).

RESULTS AND DISCUSSION

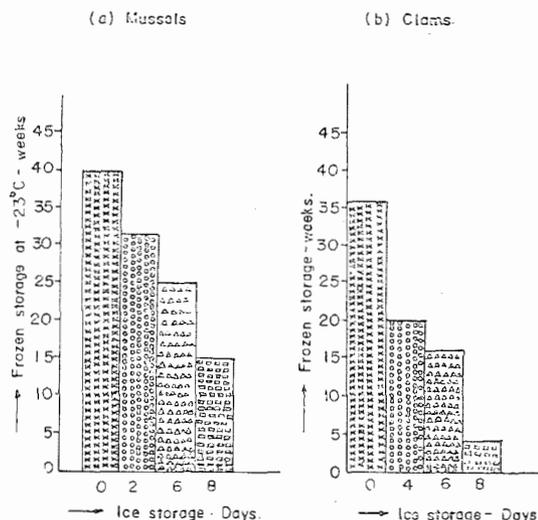
The results on protein solubility, moisture, free  $\alpha$  -amino nitrogen, inorganic phosphorus & bacterial count of frozen mussel and clam meat stored for 44 and 36 weeks, respectively, at  $-23^{\circ}\text{C}$  are represented in tables 1 - 2 and the shelf - life based on colour and flavour is represented in Fig. 1. During 44 weeks of storage, the moisture content dropped from 79 to 74% in fresh uniced mussels and from 78 to 75% in material iced for 8 days. During 36 weeks of storage, the moisture content dropped from 78 to 75% in the fresh uniced clams and from 82 to 79% for material iced for 8 days. The amount of protein extractable in Dyers buffer showed a decreasing trend in both cases.



A gradual decrease in free  $\alpha$  -amino nitrogen content is observed in mussel meat and clam meat stored in ice as well as during frozen storage. The decrease may partly be due to leaching while in contact with ice and may be one of the contributing factors in

lessening the flavour of material stored for extended periods.

Fig 1 SHELF LIFE



The inorganic phosphorus content (table 1 (a) & (b)) register an increasing trend during cold storage probably due to the release of phosphate ions from sugar phosphates and other phosphorus compounds and the fall in values observed in ice stored material can be accounted for the leaching effect by ice melt water.

The drip volume and its amino nitrogen and inorganic phosphorus contents are depicted in table 1 (a) & (b). The drip characteristics have been shown to bear a direct relationship to the quality of the product as is clear from Fig. 1 (a) & (b). Duration and temperature of frozen storage are the important factors influencing the drip loss. Both in mussels and clams, the drip loss showed an increasing trend during frozen storage.

The bacterial load and the count of pathogenic organisms like *E. coli*. and *F. streptococci* showed considerable variation during cold storage (Table 2 (a) & (b). Standard plate count during ice storage showed

TABLE 1 (b)

BIOCHEMICAL CHANGES IN CLAMS DURING FREEZING AND STORAGE

Pre- Frozen process storage ice weeks	Moisture%				Salt soluble protein as % of total protein				Free $\alpha$ -NH <sub>2</sub> -N. mg%.				Inorganic phosphate (mg P %)			
	days →															
	0	4	6	8	0	4	6	8	0	4	6	8	0	4	6	8
Raw material	78.2	80.5	81.9	82.2	63.0	61.0	59.6	59.4	212.8	151.2	126.0	114.8	46.1	32.9	25.2	28.2
0	76.5	78.8	80.1	80.5	60.9	58.1	57.2	56.2	198.8	151.2	137.2	112.0	42.8	39.3	33.9	30.0
8	75.3	78.3	79.3	80.1	57.9	55.3	54.8	53.5	204.5	159.6	126.0	98.0	49.6	42.1	37.4	36.9
16	75.8	78.3	79.4	79.4	55.1	55.1	52.8	50.3	196.0	145.6	131.6	106.4	45.7	38.2	35.6	32.8
24	76.1	78.0	79.1	79.1	54.5	50.3	50.2	49.1	212.8	162.5	120.6	103.6	53.3	43.9	41.9	38.6
36	75.4	77.8	78.8	79.4	55.0	50.8	49.8	47.3	215.2	170.8	125.3	107.5	57.5	46.9	43.8	38.3

DRIP CONSTITUENTS

Frozen storage weeks	Preprocess ice storage days →	Drip volume (ml.)				Free $\alpha$ -NH <sub>2</sub> N. (mg%)				Inorganic phosphate (mg P %)			
		days →											
		0	4	6	8	0	4	6	8	0	4	6	8
0		19.5	31.3	34.9	35.6	38.1	41.0	49.8	47.8	7.2	9.3	8.9	8.1
8		28.1	33.7	41.3	49.6	53.2	48.2	62.4	67.4	12.2	11.3	11.8	13.5
16		30.6	38.7	46.9	47.4	63.2	54.7	69.0	68.3	14.6	13.7	14.3	13.7
24		36.5	43.8	48.1	52.1	66.9	64.5	75.9	84.4	16.1	16.7	15.9	17.2
36		38.7	44.7	49.0	55.8	81.0	77.9	84.2	89.8	16.8	18.8	17.1	19.1

Chinnamma George: Cold storage changes in mussels (*Mytilus edulis*) and clams (*Villorita* sp.)

TABLE II (a)

## CHANGES IN BACTERIAL LOAD DURING FREEZING AND STORAGE IN MUSSELS

Frozen storage weeks	Preprocess ice storage days	Standard plate count per g.				Escherichia coli per g.				Faecal streptococci per g.			
		→ 0	2	6	8	0	2	6	8	0	2	6	8
Raw material		$3.8 \times 10^5$	$6.5 \times 10^5$	$3.5 \times 10^6$	$1.7 \times 10^7$	330	370	175	111	280	211	168	178
2		$4.5 \times 10^4$	$8.1 \times 10^4$	$6.9 \times 10^5$	$2.2 \times 10^6$	44	25	11	14	125	85	72	58
12		$1.7 \times 10^4$	$4.4 \times 10^4$	$1.9 \times 10^5$	$8.0 \times 10^5$	57	14	Nil	Nil	93	71	78	44
22		$7.0 \times 10^3$	$1.5 \times 10^4$	$6.5 \times 10^4$	$4.9 \times 10^5$	Nil	Nil	Nil	Nil	29	13	8	16
32		$2.4 \times 10^3$	$7.7 \times 10^3$	$3.1 \times 10^4$	$3.7 \times 10^5$	Nil	Nil	Nil	Nil	15	21	Nil	8
44		$1.6 \times 10^3$	$6.0 \times 10^3$	$2.2 \times 10^4$	$1.7 \times 10^5$	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

TABLE II (b)

## CHANGES IN BACTERIAL LOAD DURING FREEZING AND STORAGE IN CLAMS

Frozen storage weeks	Preprocess ice storage days	Standard plate count per g.			Escherichia coli per g.				Faecal streptococci per g.				
		→ 0	4	6	8	0	4	6	8	0	4	6	8
Raw material		$2.2 \times 10^5$	$9.8 \times 10^5$	$6.7 \times 10^5$	$1.0 \times 10^6$	300	172	151	97	131	91	65	49
0		$3.1 \times 10^4$	$1.5 \times 10^5$	$3.0 \times 10^5$	$7.0 \times 10^5$	132	71	25	Nil	72	32	13	Nil
8		$2.5 \times 10^4$	$7.0 \times 10^4$	$9.6 \times 10^4$	$1.0 \times 10^5$	Nil	Nil	Nil	Nil	32	Nil	Nil	Nil
16		$1.0 \times 10^4$	$3.7 \times 10^4$	$7.8 \times 10^4$	$3.7 \times 10^5$	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
24		$8.9 \times 10^3$	$6.3 \times 10^3$	$1.6 \times 10^4$	$4.1 \times 10^5$	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
36		$4.3 \times 10^3$	$1.6 \times 10^4$	$3.3 \times 10^4$	$3.6 \times 10^4$	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

steady increase but during freezing and storage after 44 and 36 weeks at - 23°C, the viable count comes down by 99%: reduction in pathogenic organisms like *E. coli*. and *Faecal streptococci* is observed during frozen storage and are completely destroyed towards the end. This is in agreement with the findings of Lekshmy (1964) that faecal indicator organisms underwent significant reduction during freezing and cold storage.

The shelf - life with respect to flavour, texture and colour is depicted in Fig. 1 (a) & (b). The changes observed are mainly (1) the colour change to dull white and to brown in spoiled samples (2) the firmness and elasticity of the material replaced by sponginess and in spoiled samples the breaking up of the flesh and resultant oozing out of drip and (3) loss of the characteristic sweet flavour. In the case of mussels the fresh frozen material remained in acceptable condition for 40 weeks and the 8 days iced material only for 15 weeks, while the fresh frozen clams remained in acceptable condition for only 35 weeks and the shelf

- life of 8 days iced material was only 4 weeks.

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