TECHNOLOGICAL ASPECTS OF PROCESSING OF EDIBLE MUSSELS, CLAMS AND CRABS: I. SPOILAGE DURING ICE STORAGE

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Rate and pattern of spoilage of some of the economically important edible species of shell fishes viz; *Mytilus edulis* (Mussel), *Villorita cornucopia* (Clam), *Neptunus pelagicus* (Crab) and *Scylla serrata* (Crab) have been discussed in this communication. Chemical indices used for objective evaluation of quality were water extractable nitrogen (WEN), non-protein nitrogen (NPN), free α-amino nitrogen (α-NH_2-N), glycogen, lactic acid and inorganic phosphorus in addition to the subjective tests. No significant difference in the spoilage pattern of the species during ice storage was observed and these species could be preserved in ice in organoleptically acceptable condition upto 8 days, 9 days, 8 days and 11 days respectively.

INTRODUCTION

Processing industries based on mussels, clams, crabs etc. have not so far come into existence in India in spite of the ever increasing demand in overseas countries for such delicacy foods. This is largely due to the lack of precise information on the resources and absence of technical data on the amenability of the different varieties available. The higher labour costs involved in detaching the muscle from the shell and the subsequent processing of the meat free of sand also hinder the industrial progress of certain shell fishes like clams. In India, on an average, there is a landing of about 5,000 m. tons of crustaceans and shell fishes annually excluding prawn, but about 25% of the material is spoiled due to improper transportation, storage and icing facilities.

The aim of this study was to determine the maximum period for which mussels, clams and crabs under normal icing conditions can be stored prior to freezing. More importance was given to the organoleptic and taste panel studies as none of the objective tests correlate satisfactorily with the subjective taste panel studies.

MATERIALS AND METHODS

Commercially important species of mussels i. e., *M. edulis*, obtained from

Calicut was transported to the laboratory in a refrigerated van. The most important variety of clams i. e. *V. cornucopia* was obtained from a local source. Both popular and non-popular varieties of crabs i. e., *S. serrata* and *M. pilagicus* were obtained locally.

All the different species of shell fishes were kept seperately in insulated ice boxes in direct contact with ice and at regular intervals samples were analysed for water extractable nitrogen (WEN), non-protein nitrogen (NPN), free ∝-amino nitrogen (∝-NH_2-N), glycogen, lactic acid and inorganic phosphorus. Fresh material was analysed for protein, fat and free amino acids.

i) *Moisture* was determined by the method given in IS: 2345, (1963).

ii) *Total nitrogen* was determined by the AOAC (1960) method.

iii) *Water extractable nitrogen* was determined by the Kjeldahl method.

iv) *Non-protein nitrogen* determinations were made on the trichloracetic acid extracts of the muscle by the Kjeldahl method.

v) *Free ∝-amino nitrogen*, was estimated by the method of Pope and Stevens, (1939).

vi) *Total fat*, was estimated by extracting about 1 g of the dried sample with petroleum ether (60-80°C) for about 10-12 hrs.

vii) *Ash*, was determined by the method given in IS: 2345 (1963).

viii) *Glycogen*, was estimated by the method of Van de Kliy (1951). Protein free extract obtained by treating the meat with 5% trichloro acetic acid containing 0.1% silver sulphate was allowed to react with concentrated sulphuric acid which on heating developed a characteristic colour and the reading was taken at 515 mμ.

ix) *Lactic acid*, was estimated by the method of Barker and Summerson (1941). The intensity of the coloured compound formed by the action of p. hydroxy diphenyl on acetaldehyde in the presence of cupric irons was measured at 565 mμ.

x) *Inorganic phosphorus*, was estimated by the method of Fiske and Subbarow (1925). The ammonium phospho molybdate on reduction gave a characteristic blue compound, the intensity of which was measured at 660 mμ.

xi) *Organoleptic rating:* The material cooked in 2.0% brine for 10 minutes was evaluated by the taste panel members of the Institute.

xii) *Free amino acids*, wers extracted with ethyl alcohol, and estimated by standard microbiological assay methods.

Results and discussion

The proximate compositions of *M. edulis, V. cornucopia. N. pelagicus* and *S. serrata* are given in Table I. It is evident from this table that crabs are a good source of phosphorus, while clams and mussels are that of glycogen. Mussels and clams contain higher percentage of fat than crabs, but as regards food value, clams are inferior to other shell fishes. Appreciable fluctuations in protein and glycogen contents are observed which probably vary between species, season, maturity etc. (Venkataraman and Chari, 1951). The higher rate of spoilage of shell fishes may be due to higher level of free ∝ amino nitrogen, which constitutes about 50% of the total NPN fractions. The individual free amino acid contents of fresh mussel, clam and crab *(S. serrata)* tissues are given in Table I. Distribution free ∝ NH_2-N pattern in both the groups (mollusc and crustacea) are more or less same, but crab samples in general, show higher propo-

TABLE I PROXIMATE COMPOSITION

	Mussel (*M. edulis*)	Clam *V. cornucopia*	Crabs (*N. pelagicus*)	(*S. serrata*)
1. Protein %	12.13–13.82	7.632–11.05	13.91–15.88	15.04– 15.19
2. Fat%	2.24– 2.55	0.909– 2.17	0.64– 0.92	0.26– 0.70
3. Glycogen%	8.31–10.58	1.31 – 7.91	0.16– 0.67	0.31– 4.13
4. Inorganic phosphorus mg. %	15.1 –43.18	22.6 –29.4	187–188	113.3 –195.8
5. Ash %	4.50–	4.70	7.17	5.14
6. Free amino acids mg %.				
(a) Phenyl alanine	1.234	2.15	—	4.112
(b) Glycine	2.938	1.32	—	62.71
(c) Cystine	0.132	0.018	—	0.021
(d) Tyrosine	0 932	1.87	—	6.16
(e) Histidine	1.938	2.50	—	4.13
(f) Valine	0.127	0.09	—	0.11
(g) Lysine	0.937	3.75	—	6.16
(h) Methionine	0 998	0.75	—	0.58
(i) Glutamic acid	1.107	1.40	—	1.97
(j) Isoleucine	0 031	0.56	—	0.74
(k) Leucine	1.767	3-08	—	2.50
(l) Serine	1.089	0.825	—	3.08
(m) Tryptophan	0.016	0.0112	—	0.014
(n) Proline	0.985	0.243	—	2.00
(o) Arginine	1.372	—	—	—
(p) Threonine	0.343	—	—	—

rtions of glycine, tyrosine, lysine and serine.

V. cornucopia and *N. pelagicus* have higher initial moisture levels(Fig 1),but the rate of increase of moisture level during storage is higher in *S. serrata* than in the other species.

Changes in WEN, NPN and free α-NH_2-N contents of meat during ice storage are shown in Figs 2, 3 & 4. WEN is higher in both the species of crabs *S. serrata* and *N. pelagicus* i. e; 1675 and 1510 mg% respectively as against 471 and 564 mg% in mussel and clam. WEN in all the species except *V. cornucopia* shows a gradual decrease with progressive storage due to continuous leaching by ice melt water. WEN, NPN and free α-NH_2-N values in *V. cornucopia*, also show a gradual decrease after the initial rise,which may be due to the non-opening of the shell upto 7 days thus preventing leaching, but with subsequent opening of shell, leaching starts and all the related values show a gradual decrease. During the first seven days, WEN, NPN & free α-NH_2-N values go upto 677.9, 303.1 and 81.89 mg from the initial values of 565.9, 227.5 and 56.0 mg % respectively, and on further storage the values come down to 575.2, 219.2 and 61.93 mg% respectively within 13 days. NPN of *M. edulis* shows slow but steady decrease upto 5 days followed by a sharp fall. Free α-NH_2-N and NPN are comparatively very high in crab samples and these factors particularly glycine (44 times higher than that of clam) may probably be responsible for the sweet

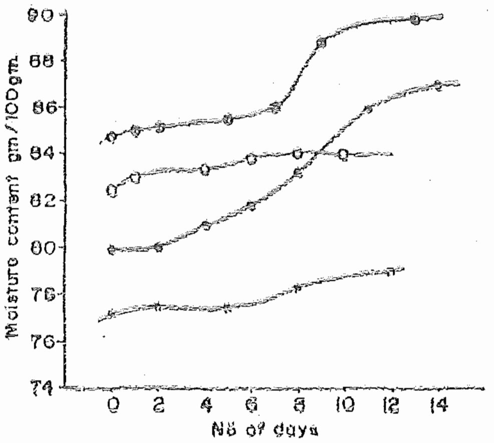

Fig 1. Changes in moisture content during ice storage.
x *M. edulis* (x) *V. cornucopia*
O *N. pelagicus* ● *S. serrata*

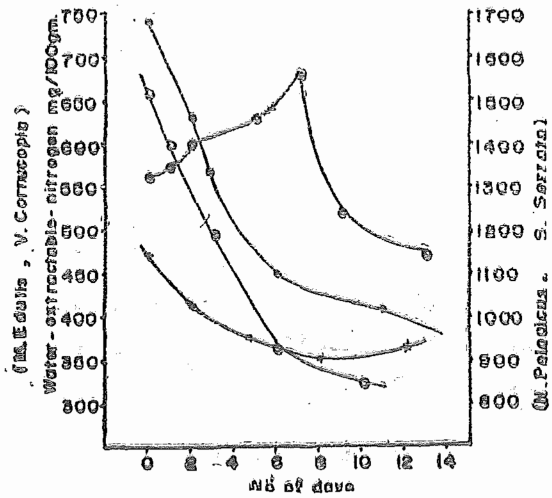

Fig 2. Changes in water extractable nitrogen fraction during ice storage.
x *M. edulis* (x). *V. cornucopia*
O *N. pelagicus* ● *S. serrata*

flavour of the meat and comparatively higher rate of spoilage (Fritz A. L., Bramstedt, 1962, Govindan, 1962).

Glycogen level is high (9.44%) in mussels than in clams (4.11%) or crabs (2.43%) and this low glycogen level is characteristic of *Neptunus* species (0.43%).

However, initial level of glycogen

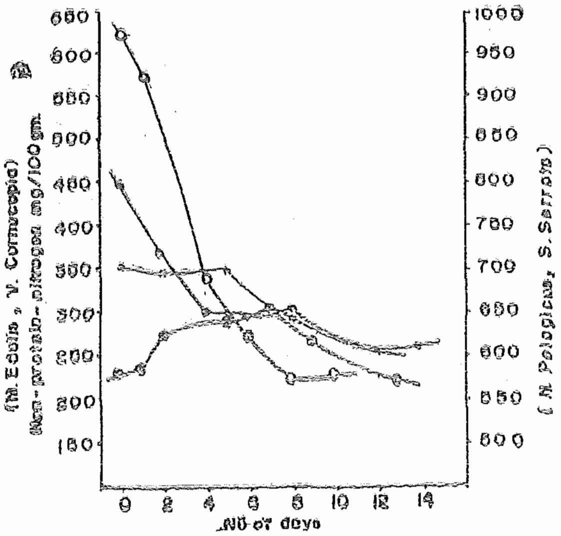

Fig 3. Changes in Non-protein nitrogen fraction during ice storage.
x *M edulis* (x) *V. cornucopia*.
O *N. pelagicus* ● *S. serrata*

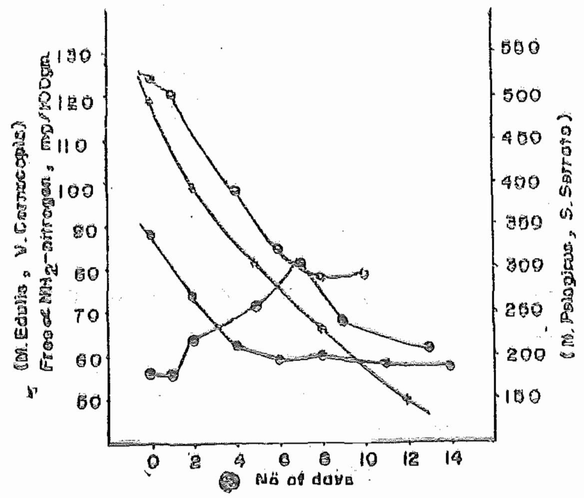

Fig 4. Changes in free ∝-amino nitrogen during ice storage.
x *M. edulis* (x) *V. cornucopia*
O *N. pelagicus* ● *S. serrata*

depends upon the condition of the material at the time of capture i. e, the amount of struggle it undergoes before death. In all the cases the values show a gradual decrease with the days of icing. Amano *et al* (1953) found different levels of glycogen content in different parts of the muscles and in all fish examined a decrease of glycogen content and a corres-

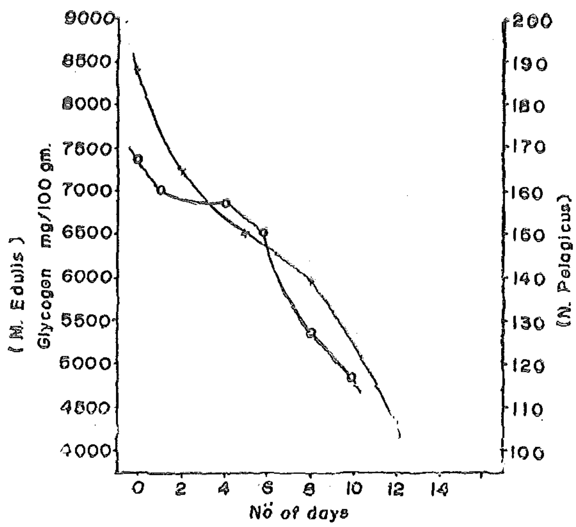

Fig 5 Changes in glycogen level during ice storage
x *M edulis* O *N. pelagicus*

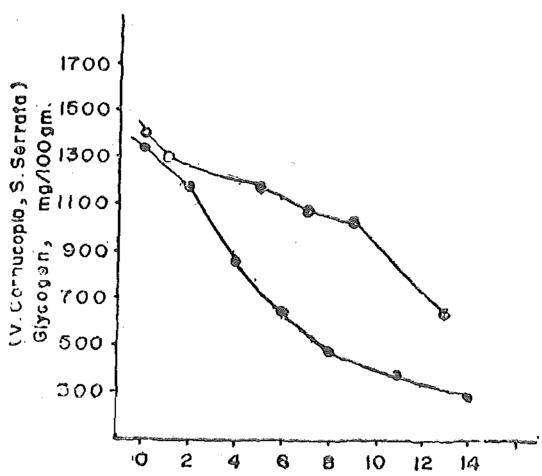

Fig 6. Changes in glycogen level during ice storage
(x) *V. cornucopia* ● *S. serrata*

ponding increase in lactic acid level depending upon the method and rapidity of killing after capture. But with the corresponding decrease in glycogen level lactic acid values in these samples do not show any corresponding increase only except in the case of *S. serrata*, where the lactic acid value goes upto 1073 mg% from the initial level of 368 mg%, but in other cases lactic acid values show a continuous decrease after an initial rise. The mechanism of depletion of glycogen level with the corresponding variation in lactic acid is not very clear, which may probably be due to other secondary reactions or the

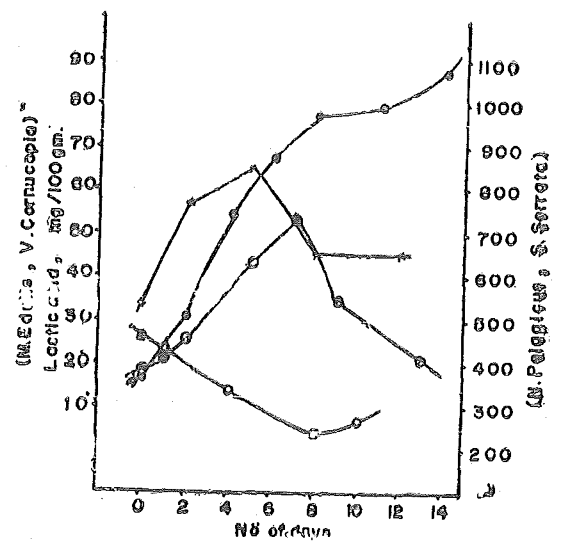

Fig 7. Changes in Lactic acid level during ice storage.
x *M. edulis* (x) *V. cornucopia*
O *N. pelagicus* ● *S. serrata*

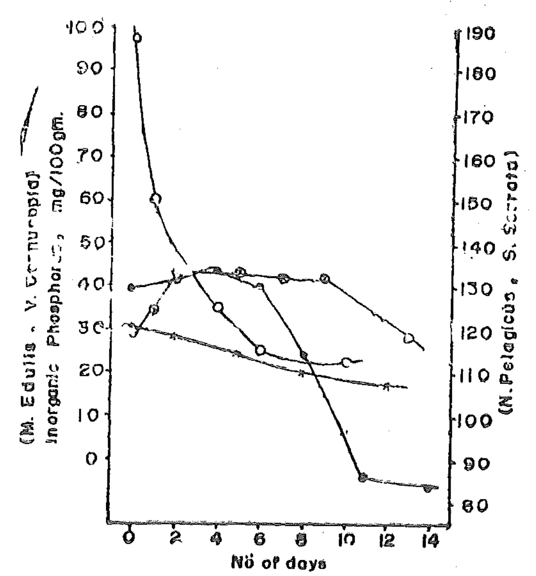

Fig 8. Changes in Inorganic Phosphorus during ice storage.
x *M. edulis* (x) *V. cornucopia*
O *N. pelagicus* ● *S. serrata*

method tried is not very specific (Schweiger & Gunther, 1964). The continuous decrease of WEN, NPN, free $\propto$-NH_2 -N, Glycogen and Lactic acid levels in *N. pelagicus* may be due to the soft cell wall which cannot prevent the leaching of water soluble fractions.

In *V. cornucopia*, inorganic phosphorus values show a gradual decrease after

TABLE II CHANGE IN ORGANOLEPTIC CHARACTERISTICS DURING STORAGE

Days of ice storage	Mussel *(M. edulis)*	Clam *(V. cornucopia)*	Crab *(N. pelagicus)*	Crab *(S. serrata)*
0 — 2	Good	Good	Good	Good
4 — 5	Fair	Fair	Fair	Good
6 — 7	Fair	Fair	Fair	Good - Fair
8	Fair - Poor	—	Fair - Poor	—
9	—	Fair - Poor	—	Fair
11	Poor	Poor	Poor	Fair - Poor
14	—	—	—	Poor

the initial rise, while the others show a gradual fall. Dephosphorylation in the initial stages of ice storage is probably responsible for higher initial values, but the fall may, mainly be due to leaching. Gangal & Magar (1963) also observed a decrease in glycogen content and an increase in lactic acid and inorganic phosphorus during rigor mortis in fish muscle.

Physical and organoleptic characteristics of shell fishes during ice storage are shown in Table II. It appears that the overall pattern of spoilage is more or less similar in Mussel *(M. edulis)*, Clam *(V. cornucopia)* and Crab *(N. pelagicus* and *S. serrata)*, the material remaining in organoleptically acceptable condition for 8, 9, 8 and 11 days respectively, during ice storage.

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