SPOILAGE OF PRAWNS AT 0° C. AND ITS ASSESSMENT BY CHEMICAL AND BACTERIOLOGICAL TESTS

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Studies on the spoilage of iced prawns and its assessment by objective tests were reported earlier (Velankar and Govindan, 1959). These studies revealed that considerable losses of 'extractives' such as the free amino-acids occur during storage of prawns in ice due to leaching. Work done in the U.S.A. (Collins *et al.*, 1960) and in India (J. R. Iyengar *et al.*, 1960) has also shown that water-soluble chemical compounds including those produced through spoilage leach out during storage in ice. In order to evaluate accurately the development of the spoilage products it is necessary to carry out the investigations on prawns held at 0° C., *i.e.*, the melting point of ice, without contact with ice. The results of these studies carried out by us are reported in the present paper.

Materials and Methods

Fresh prawns obtained from the catches made by fishing boats operating from Manasseri (Fort Cochin) and from the trawlers operated by this Station in the sea off Cochin were used in these studies. The prawns were kept iced from the time of catching till they were used for the experiments, the duration not exceeding 4 hours. The prawns were kept whole, unless otherwise stated (see following) in small flat (thickness less than 1 inch) tin cans which were closed and then placed embedded in crushed ice in an insulated box for the duration of the experiment. The temperature inside the cans reached 0° C. within 2 hours after being placed in the crushed ice.

The bacterial count, trimethylamine (TMA), total volatile nitrogen (TVN), volatile acid number (VAN), free alpha-amino-acid nitrogen and the acid-soluble orthophosphate were determined at suitable intervals during the storage period. The sampling procedure and the analytical methods employed were as described by the authors in a previous paper (Velankar *et al.*, 1961).

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RESULTS

The pattern of the development of the various spoilage indices in whole prawns are shown in Fig. 1. The curves are based on data obtained in several experiments.

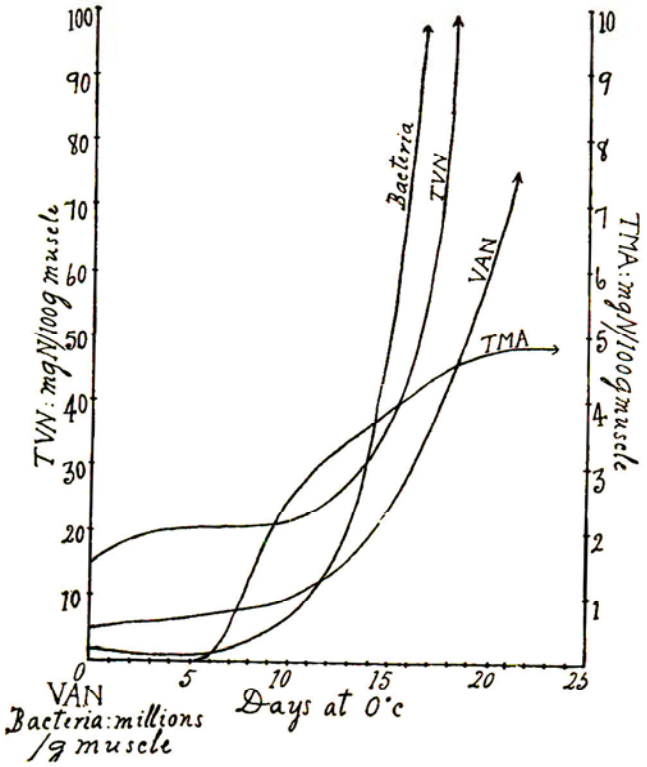

FIG. 1. Spoilage of whole prawns at 0° C.

The bacterial count decreases in the initial days of storage and begins to increase after 5 days; in about 12 days the count reaches the order of 10 million bacteria per gram of muscle. After this period the count increases rapidly to about 100 million by the 15th day of storage. The TMA is not present initially but is detectable after 5 days in storage. The TVN shows a small increase in the first 3 days of storage; after 10 days it begins to increase rapidly. The VAN which is initially less than 5 increases slowly to 10 in ten days; after this period it increases more rapidly. During storage the prawns begin to darken from the 2nd day, the percentage incidence of melanosis reaching almost 100 by the 6th day. At this time the prawn meat at the point where the head is broken off is observed to be yellow, presumably

due to autolytic spoilage. The odour becomes deep at this period though not markedly offensive.

The rise in each of the spoilage indices observed in some typical experiments is shown in Figs. 2–5 in order to illustrate the manner in which they develop.

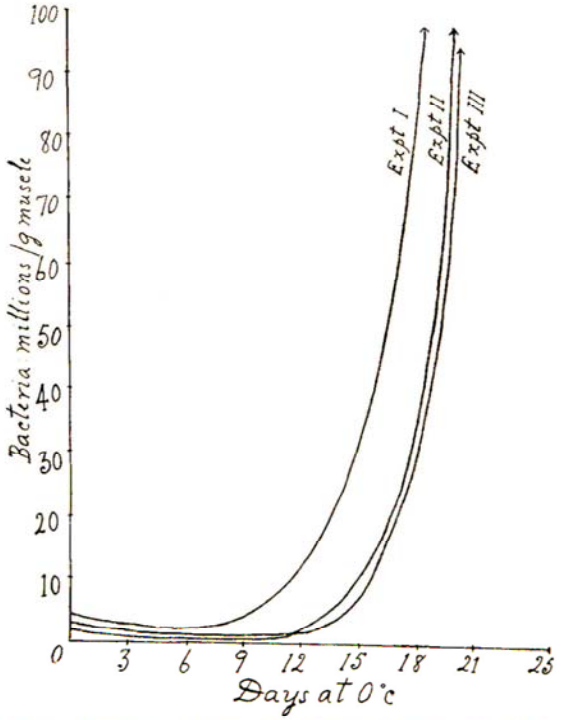

FIG. 2. Bacterial count of whole prawns at 0° C.

Commercially, besides whole prawns, prawns in ' headless ' and ' peeled ' condition are held in ice storage prior to processing, the storage duration depending on several variable factors. Investigations were therefore carried out on peeled prawns kept in tin cans embedded in ice as in the case of the whole prawns. The spoilage patterns of the peeled prawns held at 0° C. is shown in Fig. 6. Significant rise in the bacterial count, the TMA and TVN occurs only after about two weeks storage; the VAN remains characteristically low up to nearly three weeks, the value at the end of this period being about 10. Other differences are also present in the spoilage pattern of whole and peeled prawns (see following).

In order to obtain strictly comparable data on the spoilage pattern in prawns held whole, headless, and peeled conditions respectively prawns

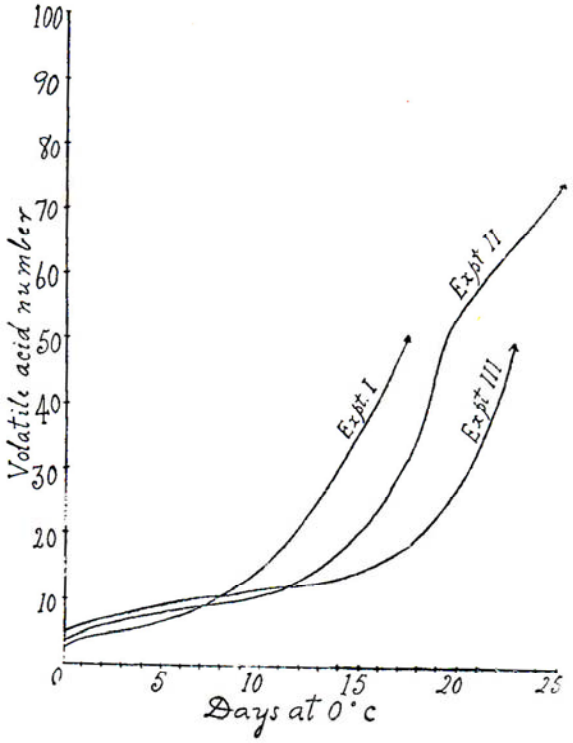

FIG. 3. Volatile acid number of whole prawns at 0° C.

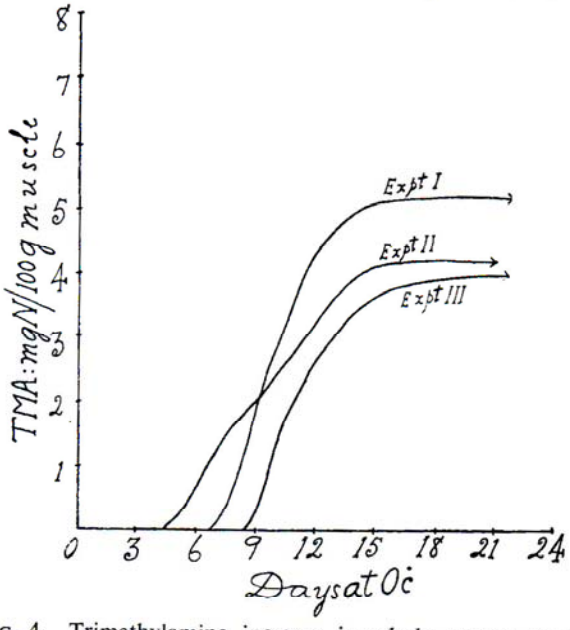

FIG. 4. Trimethylamine increase in whole prawns at 0° C.

belonging to a single species, *i.e.*, *Metapenæus dobsoni*, from a single haul were employed and experiments conducted simultaneously keeping these in cans embedded in ice as in the previous experiments. The development of the spoilage indices in these studies are shown in Figs. 7–10. Increase in the bacterial count occurs simultaneously in the whole and headless prawns; in peeled prawns it occurs a little later. Increase in the VAN occurs much earlier in the whole prawns than in the peeled prawns; in headless prawns the increase is intermediate between that in whole and peeled prawns. The TVN also increases more rapidly in whole prawns than in the peeled prawns.

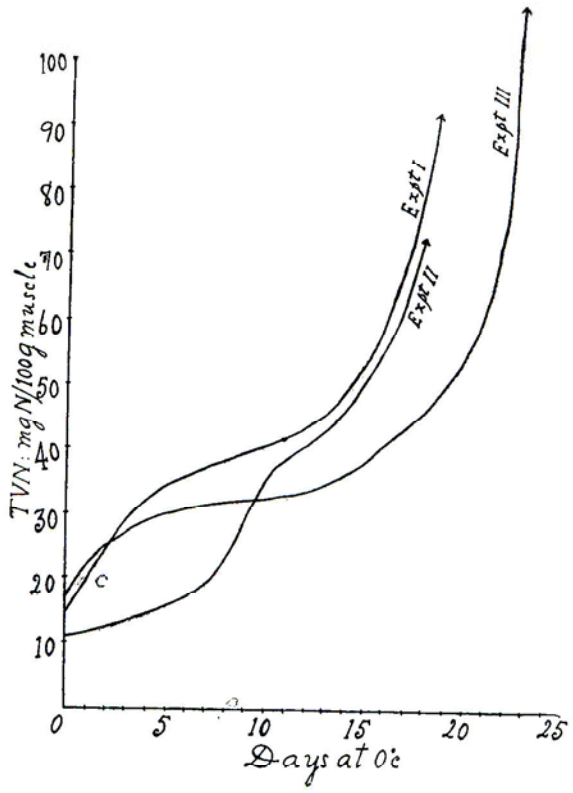

FIG. 5. Total volatile nitrogen increase in whole prawns at 0° C.

The TMA rises simultaneously in the whole and headless prawns; in the peeled prawns it is detectable only after about 20 days whereas in the whole and headless prawns it is detectable after 3 days. Incidence of melanosis was far less in the headless prawns compared with whole prawns.

The pattern of the changes occurring in the free amino-acid nitrogen content of prawn muscle during storage of whole prawns at 0° C. without

contact with ice is shown in Fig. 11. The amino nitrogen increases slowly from the initial value by about 50 mg. N/100 g. muscle in about three weeks after which it begins to decrease. Changes in the orthophosphate of the muscle occurring in whole and peeled prawns respectively are shown in

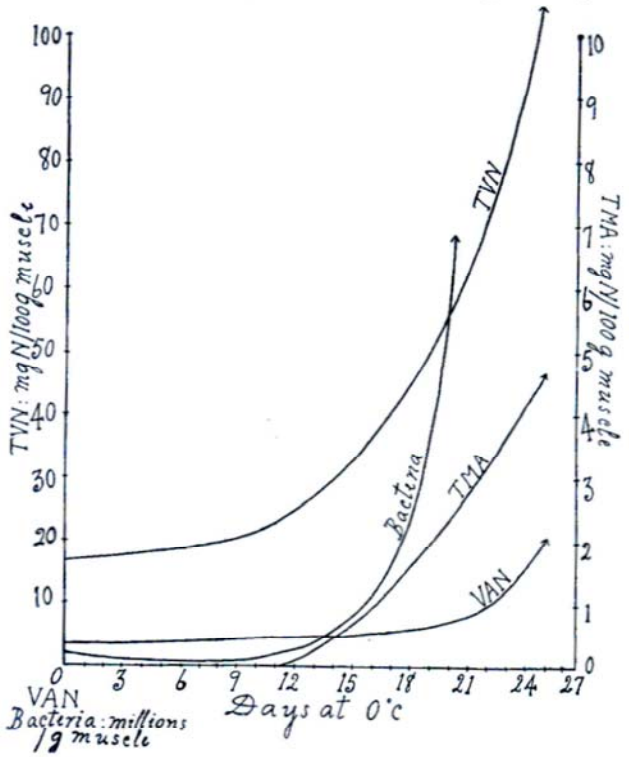

FIG. 6. Spoilage of peeled prawns at 0° C.

Fig. 12. In whole prawns the phosphate falls sharply after 4–5 days storage and continues to decrease thereafter at a much slower rate. In the peeled prawns no decrease in the orthophosphate occurs during storage at 0° C.

In order to compare the values of the spoilage indices during storage of prawns at 0° C. without contact with ice with the values observed in the case of prawns held in ice, some observations were carried out on whole prawns kept in ice. The results of this study are shown in Table I. In the earlier work on iced prawns carried out by Velankar and Govindan (*loc. cit.*) the spoilage indices studied did not include the volatile acid number.

Comparison of the figures in Table I with the observations recorded for prawns held at 0° C. without contact with ice shows the values for the iced prawns to be lower than for the uniced prawns after equal duration at 0° C.

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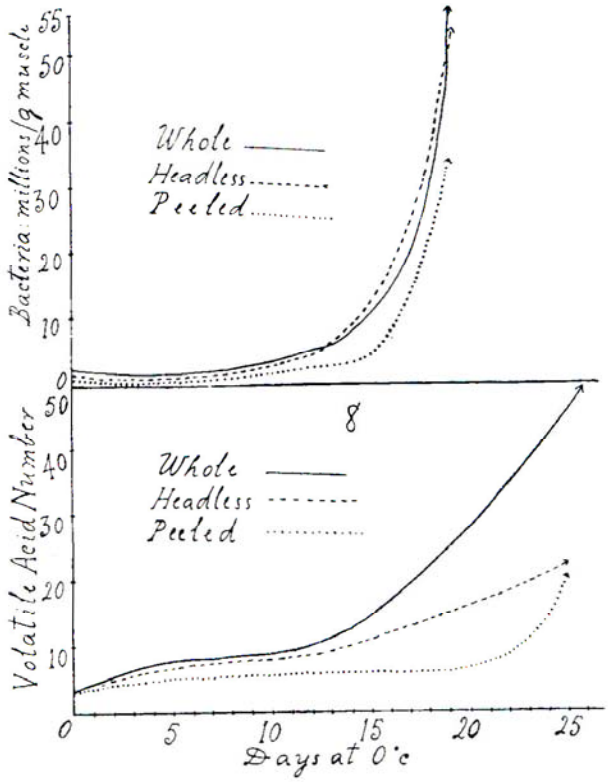


FIGS. 7–8. Fig. 7. Bacterial count. Fig. 8. Volatile acid number.

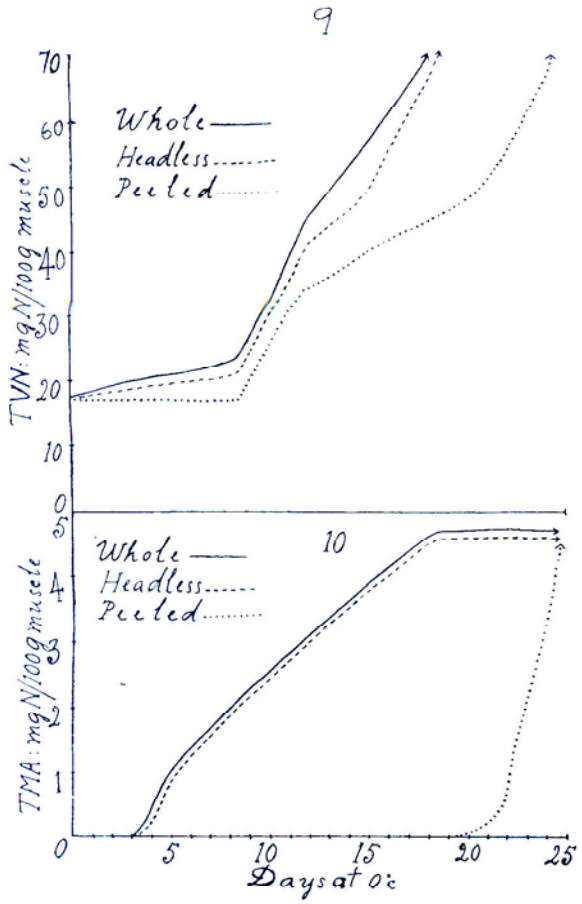
TABLE I

Spoilage of iced prawns

Days in storage	Bacterial count (million per g. muscle)	Trimethylamine (mg. N/100 g. muscle)	Total volatile nitrogen (mg. N/100 g. muscle)	Volatile acid number
0	0·54	nil	13·54	2·29
3	0·34	,,	11·78	1·91
6	0·20	,,	8·61	1·91
11	0·134	,,	7·35	1·06
17	1·698	,,	3·71	0·92
21	5·20	,,	5·68	5·36
24	13·0	0·5	6·3	7·72

DISCUSSION

The period elapsing before any rise occurs in the values of the spoilage indices can be considered the limiting duration of storage of whole prawns at 0° C. when the prawns can be considered fresh. This period is about 5 days; it is interesting to note that the period is the same as found by Collins *et al.* (*loc. cit.*). The commencement of the steep rise in the spoilage indices after 10–12 days indicates the onset of spoilage.



FIGS. 9–10. Fig. 9. Total volatile nitrogen. Fig. 10. Trimethylamine.

The observed rise in the spoilage indices in iced prawns is much lower than in the prawns held without ice. This difference is largely due to loss of the spoilage compounds through leaching in the iced prawns, though a strict comparison of the spoilage pattern of prawns held in ice and prawns

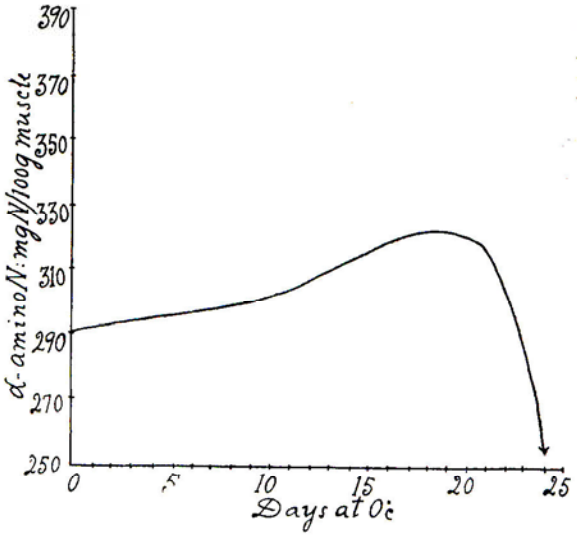


FIG. 11. Amino acid nitrogen changes in whole prawns at 0° C.

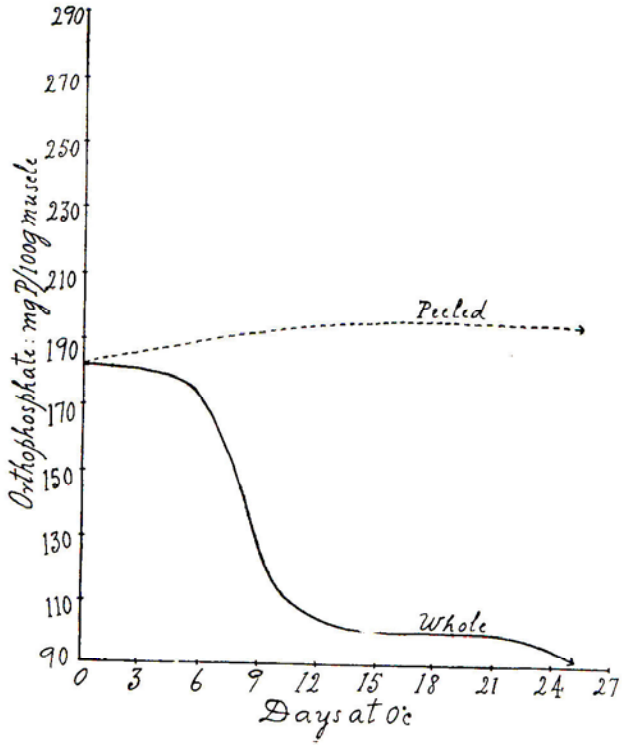


FIG. 12. Orthophosphate changes in whole and peeled prawns at 0° C.

held at 0° C. without ice, is subject to some limitations. In the case of the iced prawns the bacterial load on the external surfaces would be reduced through washing away of some of the bacteria by the melting ice. Also, in prawns held in ice the water which is also added usually in commercial handling of iced prawns, covers the surface of the prawns, thus preventing exposure of the prawns to air unlike in the prawns held without contact with ice. Melanosis incidence would therefore be expected to be more in prawns held at 0° C. without ice compared with prawns held in ice. Comparing the data and the conditions of holding the prawns it becomes obvious that the keeping quality period as seen from the objective indices would represent the minimum in the case of prawns held at 0° C. without contact with ice, and the maximum in the case of the prawns held in ice. It would be safe therefore to assume the period of 5 days indicated from the studies on prawns held without ice as the limit of storage duration at 0° C. when the prawns could be considered really fresh. The values of indices observed in prawns held without ice, though not directly applicable for assessing the quality of iced prawns, serve a valuable purpose as the reference standards.

It is noteworthy that in our present studies the bacterial count of prawns held at 0° C. decreased initially; apparently the mesophiles present in the flora of the fresh prawns do not survive long at the lower temperature; after a lag period, however, the psycrophiles present initially could be expected to multiply. This would explain the initial decrease in the bacterial count of prawns held at 0° C. and the subsequent rise.

The observed free amino-acid nitrogen concentration represents the resultant of the increase in the free amino-acids due to degradation of the protenoid substances and their decrease due to their utilisation by the bacteria, both processes presumably proceeding simultaneously. The absence of any decrease in the free amino-acid nitrogen in prawns held without ice unlike in iced prawns is in conformity with the previous observation made by Velankar and Govindan that the decrease in the free amino nitrogen is due to leaching (Velankar and Govindan, *loc. cit.*).

The curves representing the development of the spoilage indices (Figs. 7–10) indicate that peeled prawns keep better than whole prawns, headless prawns having keeping properties intermediate between the whole and peeled prawns. A possible explanation for these differences is that the cephalothorax and the exoskeleton, which is the source of surface and gut spoilage, have been removed in the case of the peeled prawns unlike in the whole prawns. Surface spoilage seems to be more significant than gut spoilage since the peeled prawns keep better than the headless prawns.

A characteristic feature of the peeled prawn spoilage is the very slow development of the VAN unlike in the whole prawns; also, in peeled prawns there is no decrease in the orthophosphate unlike in the whole prawns. The reasons for these differences are not clear at present.

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