Shelf life of frozen stored mud crab (*Scylla serrata*) meat

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**ABSTRACT**

Shelf life of mud crab (*Scylla serrata*) meat during frozen storage at -20 °C for 200 days was determined by chemical and sensory evaluation. The results indicated that crab meat can be stored in an acceptable condition for 130 days. During frozen storage, decreases in pH, moisture, total nitrogen and glycogen were noticed. Among the freshness parameters, lactic acid (212.6 to 388.8 mg%), Total volatile base nitrogen, TVBN (2.6 to 32.7 mg%), Trimethylamine nitrogen peroxide value, TMAN (1.01 to 17.55 mg%) and Peroxide value, PV (0.84 to 27.93 milli moles of oxygen/kg of fat) increased, whereas non-protein nitrogen, NPN (417.4 to 356.8 mg%) and alpha amino nitrogen, AAN (292.2 to 251.8 mg%) values decreased. Sensory evaluation of the frozen stored crab meat revealed the limits of acceptability of the product to be TVBN 18.2 mg%, TMAN 7.25 mg% and PV 15.13 millimoles of oxygen per kg fat.

**Introduction**

In recent years, culture and processing of mud crab (*Scylla serrata*) have undergone extensive development because of the increasing demand in overseas countries. Previous investigators have examined the influence of seasonal parameters on meat composition and yield (George and James, 1971; George and Gopakumar, 1988). Although technological aspects of preservation and processing of crab meat during ice storage, freezing and frozen storage have been studied by several investigators (Chinnamma et al., 1970; George, 1973; 1974), studies on shelf life of crab meat under frozen storage are very limited.

Crab meat undergoes changes in chemical, microbial and organoleptic characteristics during frozen storage. These alterations could be used to measure the shelf life of the product. Considering the importance of crab meat as an export commodity, it is necessary to establish the shelf life during frozen storage in order to maintain proper quality standards. The present paper describes the keeping quality of mud crab (*Scylla serrata*) during storage at -20°C as assessed by biochemical parameters and sensory means.

**Materials and methods**

Live, medium-sized crabs, *Scylla serrata* (average carapace width 98.2 mm and mean weight 175.5g) caught off Chilka lake were butchered, cleaned properly, de-shelled and then the muscle flakes were separated. One hundred grams each of the crab meat were packed in low density polyethylene and immediately frozen in a Laboratory model coil freezer (Instrumentation India Ltd., Kolkata) for 48 h, glazed and stored at -20°C in a master carton. Samples were drawn randomly at 25 days intervals and analysed for chemical and organoleptic qualities.

**Chemical analyses**

Moisture was estimated as per AOAC (1975). pH of the meat was determined using digital pH meter (MK-VI model of Systronics make, Ahmedabad) after mixing 10 g of minced meat with 50 ml distilled water. Thaw drip (TD) in frozen meat was determined by the procedure of Mishra and Srirvakan (1989). Total lipids (TL) were extracted with chloroform – methanol as described by Bligh and Dyer (1959). Total nitrogen (TN) and non-protein nitrogen (NPN) were determined by the method of Srirvakan and Chandru (1983), glycogen by the method of Sifter et al. (1950). Peroxide value (PV) was determined according to Jacobs (1958) while trimethylamine nitrogen (TMAN) and total volatile base nitrogen (TVBN) were estimated by the method of Beatty and Gibbons (1937). Alpha amino nitrogen (AAN) in the sample was estimated following the copper method of Pope and Stevens (1939).

**Sensory evaluation**

The crab meat sample was steam cooked for a period of 2 min with 2% salt, cooled and assessed for organoleptic qualities by eight trained panelists on the basis of appearance, colour, odour, taste, flavour, texture and overall acceptance (OAA) using a five point hedonic scale range (Mishra and Srikar, 1989).
Statistical analyses

The data from chemical analyses were subjected to ANOVA and Duncan's new multiple range test (Duncan, 1955) to determine differences between experimental period of storages. The mean sensory scores for OAA of the product were correlated with storage time and the shelf life of the crab meat during frozen storage using linear regression plot.

Results and discussion

Changes in thaw drip percentage and proximate composition during frozen storage of crab meat are given in Table 1. Thaw drip (TD) loss increased from 7.52 to 15.94% during 200 days. It has been observed that the thaw drip loss in crustaceans during frozen storage is largely affected by the duration and temperature of storage (George, 1974). Free drip to a certain extent reflects the degree of protein denaturation resulting from surface dehydration, ice crystal formation and cell rupture. In the present investigation, a negative correlation existed between thaw drip and overall acceptable scores (p<0.05). Moisture content of the crab meat decreased from 79.5 to 75.21% during 200 days of frozen storage. Total nitrogen (TN) decreased from 1.84 to 1.54% (p<0.05), but the decrease was not significant during the first 75 days of frozen storage. The total lipids (TL) fluctuated from 1.95 to 2.10%. A decrease in moisture and total nitrogen was observed by George (1973; 1974) in frozen crab meat.

Crabs are known to contain high amounts of glycogen which vary with season and condition of the materials. Glycogen content decreased from 4.21 to 3.28% during storage at -20°C (p< 0.05). A 22.09% reduction was observed in the present study which corroborates with the observation of Mishra and Srikar (1989) in M. casta (16.5%) and Slabyj and Carpenter (1977) in M. edulis (12%). This decrease may be attributed partly to the breakdown of glycogen in post-mortem muscle. Further, loss through thaw drip could not be ruled out. In the present investigation, negative correlation existed between the glycogen and lactic acid content (p< 0.05). Lactic acid content increased steadily from 212.6 mg% to 388.8 mg% (p < 0.05) and pH of crab meat decreased from 6.4 to 5.8 during 200 days of storage at -20°C (Table 2). The production of lactic acid due to anaerobic glycolysis was the prime factor determining the muscle acidity and consequent toughness and change of flavour which resulted in lowering of pH. Similar result has been reported by George and Gopakumar (1988).

Table 1. Changes in proximate composition and thaw drip loss in mud crab meat during frozen storage at -20°C (N=5)

<table>
<thead>
<tr>
<th>Storage period (Days)</th>
<th>Thaw drip (%)</th>
<th>Moisture (%) Mean ± SD</th>
<th>Total N (%) Mean ± SD</th>
<th>Total Lipid (%) Mean ± SD</th>
<th>Glycogen (%) Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.52</td>
<td>79.5 ± 0.04</td>
<td>1.84 ±0.06</td>
<td>1.95 ±0.02</td>
<td>4.21±0.21</td>
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<tr>
<td>25</td>
<td>8.95</td>
<td>79.24 ± 0.05</td>
<td>1.81 ±0.04</td>
<td>1.99±0.04</td>
<td>4.32±0.16</td>
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<tr>
<td>50</td>
<td>9.76</td>
<td>78.47 ± 0.01</td>
<td>1.75 ±0.02</td>
<td>2.05±0.02</td>
<td>4.13±0.12</td>
</tr>
<tr>
<td>75</td>
<td>11.23</td>
<td>77.21 ± 0.04</td>
<td>1.73 ±0.03</td>
<td>2.08±0.03</td>
<td>3.93±0.17</td>
</tr>
<tr>
<td>100</td>
<td>12.48</td>
<td>76.83± 0.09</td>
<td>1.70±0.05</td>
<td>2.10±0.05</td>
<td>3.86±0.15</td>
</tr>
<tr>
<td>125</td>
<td>13.65</td>
<td>76.24 ± 0.03</td>
<td>1.67 ±0.05</td>
<td>2.13±0.01</td>
<td>3.78±0.011</td>
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<tr>
<td>150</td>
<td>15.17</td>
<td>76.41 ± 0.06</td>
<td>1.69 ±0.04</td>
<td>2.15±0.01</td>
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<td>175</td>
<td>16.32</td>
<td>75.84± 0.05</td>
<td>1.61 ±0.06</td>
<td>2.15±0.04</td>
<td>3.48±0.18</td>
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<tr>
<td>200</td>
<td>15.94</td>
<td>75.21± 0.05</td>
<td>1.54 ±0.03</td>
<td>2.10±0.03</td>
<td>3.28±0.18</td>
</tr>
</tbody>
</table>

Varied superscripts (in columns) indicate significant differences at 5% probability

Table 2. Changes in freshness parameters during frozen storage of crab meat

| Storage period (days) | pH  | AAN mg% Mean ± SD | TVBN mg% Mean ± SD | TMAN mg% Mean ± SD | PV (millimoles of oxygen/kg fat) Mean ± SD | NPN mg% Mean ± SD | Lactic acid mg% |
|-----------------------|-----|-------------------|--------------------|--------------------|------------------------------------------|-------------------|----------------|---------------|
| 0                     | 6.4 | 292.2±0.13        | 6.16±0.21          | 0.04±0.01          | 0.84±0.2                                 | 417.4±0.26        | 212.6         |
| 25                    | 6.5 | 284.3±0.07        | 6.3±0.22           | 1.89±0.08          | 1.14±0.08                                | 406.1±0.18        | 244.5         |
| 50                    | 6.4 | 272.9±0.11        | 9.8±0.17           | 2.34±0.14          | 1.36±0.11                                | 389.3±0.15        | 263.3         |
| 75                    | 6.1 | 280.8±0.12        | 14.1±0.19          | 3.85±0.17          | 3.64±0.13                                | 402.8±0.11        | 288.7         |
| 100                   | 6.2 | 272.7±0.10        | 16.3±0.09          | 5.94±0.08          | 10.73±0.09                               | 391.6±0.14        | 303.5         |
| 125                   | 6.0 | 268.4±0.08        | 17.5±0.21          | 6.76±0.17          | 13.68±0.12                               | 383.4±0.15        | 334.6         |
| 150                   | 6.2 | 263.8±0.09        | 22.4±0.12          | 7.97±0.12          | 18.06±0.13                               | 375.8±0.12        | 347.7         |
| 175                   | 5.8 | 257.3±0.10        | 28.7±0.18          | 13.30±0.14         | 22.34±0.10                               | 367.6±0.10        | 372.3         |
| 200                   | 5.8 | 251.8±0.12        | 32.7±0.12          | 17.55±0.15         | 27.93±0.11                               | 356.8±0.11        | 388.8         |

Varied superscripts (in columns) indicate significant differences at 5% probability
Changes in freshness parameters viz., PV, TMAN and TVBN in frozen stored crab meat are given in Table 2. Peroxide value increased from 0.84 to 27.93 millimoles of oxygen per kg fat during 200 days of frozen storage (p < 0.05) indicating that crab meat lipids are oxidised during frozen storage. Total volatile base nitrogen and TMAN contents increased significantly from 1.6 to 32.7 mg % and 0.04 to 17.55 mg % respectively during frozen storage (p < 0.05). The amount of trimethylamine (TMA) is widely used as an index of spoilage in fish. Trimethylamine nitrogen and TVBN were negligible in fresh crab meat while these increased gradually as spoilage advanced during frozen storage. Similar observations have been recorded by George and Gopakumar (1988) and George (1973; 1974).

The NPN and AAN showed a significant decrease from 417.4 to 356.8 mg % and 292.2 to 251.8 mg % respectively (p < 0.05). Molluscs and crustaceans are known to contain high quantities of free amino acids in their muscle, the AAN accounting for 20 to 70% of NPN (Konosu, 1972). AAN of crab meat in the present study constitutes 69.76% of NPN. The decrease in amino nitrogen could be attributed to the deamination of amino acids and possible loss through drip. Similar observation has been reported by Mishra and Srikar (1989) in M. casta during frozen storage. The decrease in AAN further paralleled the loss in flavour.

A significant decrease in organoleptic scores (p < 0.05) was noticed for all the characteristics judged throughout the period of storage (Table 3). These results confirm previous observations that the sensory acceptability of crabs (George, 1973) and bivalves (Mishra and Srikar, 1989) held under frozen storage conditions decline steadily. Sensory evaluation data for frozen stored crab meat showed a high negative correlation between mean panel scores for overall acceptance and storage period.

A linear regression equation Y = -0.0164 X + 4.1354, with a correlation coefficient r = -0.9897 was obtained. The product was rated fair upto 75 days and acceptable upto 130 days. A comparative evaluation of organoleptic and chemical scores indicated that product which was rated fair during the first 75 days had TVBN 14.1 mg%, TMAN 3.85 mg% and PV 3.64 millimoles of oxygen per kg fat. However, the product was in acceptable condition during 130 days of storage at -20°C, the corresponding chemical scores being TVBN d” 18.2mg%, TMAN d” 7.25 mg%, PV d” 15.13 millimoles of oxygen per kg fat. Beyond these values, the crab meat was found to be unacceptable.

The results of the present investigation indicate that crab meat stored under frozen conditions undergo a progressive decline of sensory quality which is clearly associated with storage duration.

Table 3. Sensory performance of crab meat under frozen storage

<table>
<thead>
<tr>
<th>Storage period (days)</th>
<th>Appearance</th>
<th>Colour</th>
<th>Odour</th>
<th>Taste</th>
<th>Flavour</th>
<th>Texture</th>
<th>Overall acceptability</th>
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<td>3.4</td>
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<tr>
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<td>3.6*</td>
<td>3.6*</td>
<td>3.2*</td>
<td>3.2*</td>
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<td>3.0*</td>
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</tr>
</tbody>
</table>

Varied superscripts (in columns) indicate significant differences at 5% probability

References


George, C. and James, A. 1971. Technological aspects of preservation and processing of edible shellfishes. II. Influence of season on the chemical composition of crab (Scylla serrata). Fish. Technol., 8(1) : 83.


