

Studies on the post-mortem changes in shrimp and prawn during ice storage: II. Biochemical aspects of quality changes

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Abstract

Studies were conducted on biochemical changes in *P. monodon* and *M. rosenbergii* during ice storage. At the end of 10 days of ice storage, moisture and protein content of freshwater prawn slightly decreased from 78.34 to 77.35% and 18.46 to 17.10, respectively, while lipid and ash content slightly increased. The moisture, crude protein, lipid and ash content of one day ice stored tiger shrimp samples were 78.07, 18.06, 1.3 and 1.29% respectively. The protein composition of fresh water prawn immediately after killed were 36.51% sarcoplasmic, 44.63% myofibrillar, 8.12% stroma and 6.44% alkali soluble protein. At the end of 10 days of ice storage, sarcoplasmic and stroma protein slightly decreased while there was little or no changes observed in myofibrillar and alkali soluble protein. In case of one day ice stored tiger shrimp, the composition of protein were 35.32% sarcoplasmic, 46.29% myofibrillar, 7.86% stroma protein and 7.08% alkali soluble protein. At the end of 10 days in ice, sarcoplasmic protein decreased from 35.32% to 32.16% while there was slight change in other protein fractions. The TVB-N value of 1 day ice stored shrimp was 10.5 mg/100g of sample. It increased gradually with the lapse of storage period and at the end of 10 days storage in ice, the value increased up to 60 mg/100g sample. The tiger head on shrimp in ice storage were found organoleptically acceptable condition for 8 days and at that time the TVB-N values were 32.2 mg/100g which is slightly above the recommended limit for TVB-N for export.

Key words: *Penaeus monodon*, *Macrobrachium rosenbergii*, Ice storage, Quality change

Introduction

Fish and shellfish muscle protein is known to consist of sarcoplasmic myofibrillar, alkali soluble and stroma protein fractions and the extractability of muscle protein varies from species to species and according to the post-mortem changes (Mauruyama and Suzuki 1968, Hashimoto *et al.* 1979 and Suzuki and Watabe 1987). Preservation of shrimp in the ice or other refrigerated media is an important way of delaying biochemical changes or in other words, preventing deterioration from spoilage. It is well known that protein and other components of shrimp are generally labile and denature or degrade very quickly. Because of influence of chemical composition on keeping quality, it is important to determine the proximate chemical composition (moisture, fat, protein,

and ash) of the samples, although chemical composition varies with season and fishing ground. To assess the potentialities of effective utilization of shrimp for industrial purposes and also to determine the changes during storage it is necessary to know the composition of material under investigation.

It is well known that a variety of chemical compounds or groups of compounds accumulate in post-mortem fish flesh. These chemical compounds are intermediaries or end products of biochemical changes occur in the muscle of fish after they have died or result from the action of exogenous bacterial enzymes released by the bacteria. The amount formed can be used as an index of spoilage. It is, therefore, of interest to see the changes in pH and TVB-N values during the ice storage. There has been an extensive series of studies on the value of pH and TVB-N as a measure of fish spoilage but very little is known the freshwater prawn and marine tiger shrimp of Bangladesh.

Materials and methods

Samples

Giant freshwater prawn (*Macrobrachium rosenbergii*) and marine tiger shrimp (*Panaeus monodon*) were used for the study. Live fresh water giant prawns were collected from local market of BAU, Mymensingh. They were caught by the cast net from the nearby Brahmaputra river by fishermen and transported to the market in live condition. While the tiger shrimp were obtained in lots from coastal farms in live condition and transported to the Laboratory, Department of Fisheries Technology, BAU, Mymensingh. It took about 18–24 hours from catch point until start of the experiment.

Biochemical analysis

For muscle pH, two grams of peeled shrimp muscles were homogenized with 10 ml distilled water in a blender and the pH was measured using a pH meter (Corning Model 250).

Fresh ice stored shrimp were used for the study of protein fractionation. After removing the shell, twenty grams of muscle was fractionated by a procedure described by Hashimoto *et al.* (1979). All the operations were performed at 3–4°C as quantitatively as possible. The protein obtained after fractionation was determined by Kjeldahl method. TVB of the samples were determined according to the method described in European Commission (1997). Proximate analysis such as moisture, ash, lipid and crude protein were carried out according to the methods given in AOAC (1980).

Results

The changes in proximate composition of freshwater giant prawn and tiger shrimp are presented in Table 1. The initial moisture, protein, lipid and ash content of freshwater prawn were 78.34, 18.46, 1.8 and 1.15%, respectively. At the end of 10 days of ice storage, moisture and protein contents slightly decreased from 78.34 to 77.35% and

18.46 to 17.05%, respectively while lipid and ash contents slightly increased. For convenient of calculation, the protein, lipid and ash contents were calculated on dry weight basis. On moisture free basis, protein contents decreased considerably from 85.22 to 75.27%. There is little or no change in lipid content while ash content slightly increased.

Table 1. Changes of proximate composition of tiger shrimp and giant freshwater prawn during ice storage

Name of species	Storage period in ice (day)	Moisture %	Protein %	Lipid %	Ash %
<i>Macrobrachium rosenbergii</i>	0	78.34	18.46 (85.22)*	1.8 (8.31)*	1.15 (5.30)*
	10	77.35	17.05 (75.27)*	1.9 (8.38)*	1.42 (6.25)*
<i>Penaeus monodon</i>	1	78.07	18.06 (82.35)*	1.3 (5.92)*	1.29 (5.80)*
	10	77.96	16.85 (76.45)*	1.35 (6.25)*	1.69 (7.66)*

*Results in parentheses expressed as dry wt basis.

Proximate composition of tiger shrimp was also investigated with one day old ice stored samples. The moisture, crude protein, lipid and ash content of the samples were 78.07, 18.06, 1.30 and 1.29%, respectively. At the end of 10 days of storage, there was little or no change of moisture content. During the storage on wet weight basis, protein content decreased from 18.06 to 16.85 while on moisture free basis, it decreased considerably from 82.35 to 76.45%. There is little change in lipid and ash content either in wet weight and dry weight basis.

The changes in protein fraction of giant fresh water prawn and tiger shrimp are presented in Table 2. The composition of fresh water prawn immediately after killed were 36.51% sarcoplasmic, 44.63% myofibrillar, 8.12% stroma and 6.44% alkali soluble protein. At the end of 10 days of ice storage, some changes in composition were occurred in protein fraction. Sarcoplasmic and stroma protein slightly decreased while there was little or no changes occurred in myofibrillar and alkali soluble protein.

Table 2. Changes of protein fraction of tiger shrimp and giant fresh water prawn during ice storage

Name of species	Storage period in ice (day)	Sarcoplasmic protein (%)	Myofibrillar protein (%)	Stroma protein (%)	Alkalisoluble protein (%)
<i>Macrobrachium rosenbergii</i>	0	6.74 (36.51)*	8.24 (44.63)*	1.50 (8.12)*	1.19 (6.44)*
	10	5.82 (34.13)*	7.52 (44.10)*	1.28 (7.50)*	1.14 (6.68)*

<i>Penaeus monodon</i>	1	6.38 (35.32)*	8.36 (46.29)*	1.42 (7.86)*	1.28 (7.08)*
	10	5.42 (32.16)*	7.64 (45.34)*	1.23 (7.29)*	1.19 (7.06)*

*Results in parentheses expressed percentage of total protein.

Similar studies were also conducted with one day old ice stored tiger shrimp. The composition of protein was 35.32% Sarcoplasmic, 46.29% myofibrillar, 7.86% stroma protein and 7.08% alkali soluble protein. Some changes in composition was occurred during ice storage. At the end of 10 days in ice, sarcoplasmic protein decreased from 35.32% to 32.16% and slight changes also occurred with other protein fraction. In both experiments, the protein compositions in various fraction were almost similar where sarcoplasmic protein ranged 35.32 – 36.51%, myofibrillar 44.63 – 46.29%, stroma 8.12 – 7.85% and alkali soluble protein 6.44 – 7.08%.

Early post-mortem changes in prawn were associated with a drop in pH from 6.95 to 6.33 within an hour after death but the pH increased again during the latter phases. Fig. 1 shows the pH changes in fresh water prawn during extended ice storage for 7 days both in head-on and headless conditions. In both cases, the pH increased gradually with the lapse of storage period and at the end of 7 days of storage, the pH increased from 6.88 to 8.18 in headless and from 6.89 to 8.3 in head-on prawn.

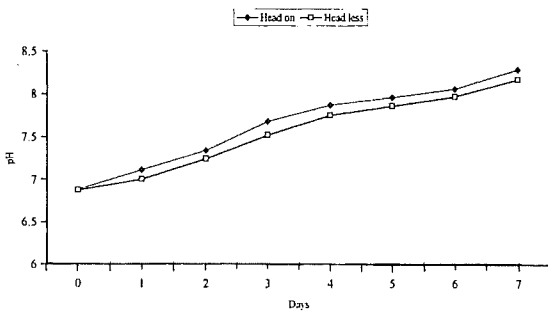


Fig.1. Changes in pH of giant freshwater prawn (head-on and headless) during ice storage.

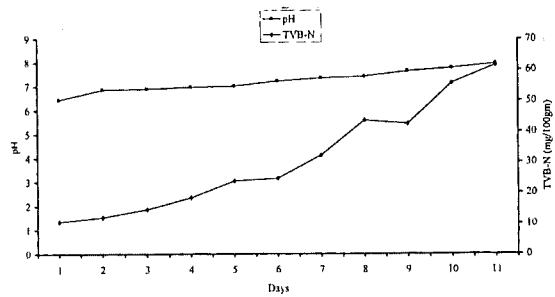


Fig.2. Changes of pH and TVB-N of tiger shrimp (head-on) during ice storage.

Studies were also conducted on the changes in pH and TVB-N values of head-on tiger shrimp during similar ice storage (Fig. 2). The pH of the samples measured 1 day after ice storage was 6.44. The pH increased slowly and at the end of 10 days of ice storage, it reached to 7.86. The TVB-N value of one day ice stored shrimp was 10.5 mg/100g of sample. It increased gradually with the lapse of storage period and at the end of 10 days storage in ice, the value increased up to 60 mg/100g sample.

Discussion

In both the experiments, an inverse relationship existed between moisture and lipid content so that some of these two constituted approximately 80%. The decrease in crude protein during 10 days of ice storage in both experiments is due to the formation of free drip accompanied by some sarcoplasmic protein. Tar (1965) reported that some loss of organic nitrogenous constituents, largely sarcoplasmic protein and inorganic salts with free drip are probable contributing factor of such loss of protein contents in chilled fish. A slight increase either in lipid or ash content during storage period could be explained by individual variation since lipid content varies greatly even within the same species. The values of proximate composition obtained in fresh water giant prawn and marine water shrimp were within the similar range reported by Babbitt *et al.* (1974) for shrimp, although proximate composition varies greatly from species to species and within the same species depending on size, sex, season and feeding habit. They reported the composition of shrimp were 78.3% moisture, 19.22% protein, 1.28% lipid and 1.77% ash content. The results obtained in the present study indicated that both freshwater prawn and tiger shrimp contained higher amount of sarcoplasmic protein and lower myofibrillar protein than that reported for teleost fishes (Shimizu and Shimidu 1960). The available reports suggest that extractability of muscle proteins varies from species to species (Shimizu *et al.* 1976). The sarcoplasmic protein are reported to extractable from ordinary muscle, even in water but in pelagic fishes, the amount of extractable proteins in the ordinary muscle reported to be increased rapidly with the increase of ionic strength of homogenate (Suzuki and Watabe 1987). However, the results of both experiments indicated that the shorter period of shelf life of shrimp/prawn during ice storage is probably related to loss of sarcoplasmic protein with free drip.

The decline in pH in early post-mortem muscle is the gradual hydrolysis during the first few hours of glycogen to lactic acid. The decline in pH also accompanied by the natural post-mortem stiffening called rigor-mortis. The available reports suggest that the generation of basic nitrogenous compound like TMA and ammonia due to bacterial action gradually rises the pH during the period after rigor-mortis has passed off. A good relationship between changes in pH and organoleptic qualities of prawn was observed where the quality gradually decreased with the increase of pH. The values above 7.5 seems to indicate spoilage. Melanosis, offensive sulphide smell and loose shell were the reasons commonly attributed for rejection.

However, the present study revealed that the head on tiger shrimp was organoleptically acceptable condition for 7 days. At that time the TVB-N value was 32.2 mg/100g which is slightly above the recommend limit for TVB-N value of exportable shrimp. The TVB-N values of 25 mg/100g is recommended for import of marine products (Cobb *et al.* 1973, Reilly and Dangla 1984, Connell 1995). According to Connell (1995) the value of 35-40 mg TVB are usually regarded as the limit beyond which whole chilled fish can be considered spoiled for most uses. The available reports suggest that the fin fish such as cod, haddock, eel and sea pike, the upper limit of 30mg TVB-N/100g is considered for acceptability.

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