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QUALITY CHANGES IN MARINE TIGER SHRIMP (*Penaeus monodon*) DURING HANDLING AND ICE STORAGE

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ABSTRACT

Studies were conducted to evaluate the initial quality and quality changes of marine tiger shrimp (*P. monodon*) obtained from farms, depots and processing plants by determining organoleptic, and biochemical aspects. The shrimp samples obtained from farms, depots and processing plants had shelf-life for 10, 7 and 6 days, respectively. The initial pH value of the shrimp samples obtained from depots and processing plants were lower than those obtained from farms. At the later stages of ice storage, the pH value of the samples obtained from farms, depots and processing plants gradually increased. The initial TVB-N values were in the range of 6.14 to 7.84 for all the samples obtained from various sources, which continuously increased during ice storage. The TVB-N values of the samples obtained from farm immediately after harvest reached slightly beyond upper limit of 25 mg/100g after 9 days of ice storage. On the other hand, the TVB-N values of the samples obtained from depot and processing plants crossed the upper limit of 25mg/100 g after 7 and 6 days of storage, respectively. There was a large fall of solubility and ATPase activity in all the samples, and this was faster in the samples from depots and processing plants.

***Key words**: Penaeus monodon*, Organoleptic and biochemical changes, Farms, Depots, Processing plants

INTRODUCTION

Fish and shellfish are most perishable food items than any other food stuffs. After harvesting they quickly undergo spoilage due to enzymatic degradation, chemical reactions and bacterial action. This spoilage pattern is accelerated due to number of causes such as complicated marketing channel, rough handling, delayed icing, insufficient and improper use of ice and so on. Since quality of raw material are essential pre-requisite for production of any good quality products, in recent years, the major importing countries are moving to impose control over the raw materials to the processing plants to minimize quality loss. The shelf life of marine tiger shrimp under various storage conditions has drawn attention among the processors to enhance the export through producing safe and wholesome food and also for designing the infrastructure for fish handling, storage, transportation and marketing at acceptable condition. However, limited information is available on the quality changes of marine tiger shrimp (*Penaeus monodon*) during handling and ice storage to the shrimp farmers, handlers, traders and workers of the processing plants in Bangladesh. The present study has been undertaken on the quality changes in marine tiger shrimp (*P. monodon*) during handling and ice storage by determining organoleptic and biochemical changes.

MATERIALS AND METHODS

Sampling

Marine tiger shrimp (*Penaeus monodon*) used for this study were collected from farms and depots of four prominent Bagda producing districts of Cox's Bazar, Khulna, Bagerhat and Paikgacha. The samples were also taken from Conception Seafoods Ltd. and Kuliar Char Seafoods of Cox,s Bazar, and Rupsha seafood processing and Allied industry and Fresh seafood industry, Khulna. The

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samples were Mymensingh in iced condition in an insulated box to assess the degree of freshness by evaluating organoleptic and biochemical changes.

Organoleptic Assessment

The organoleptic methods used in this study is based on the existing procedure of the Fish Inspection and Quality Control Service (FIQC) of the Department of Fisheries (DOF), the Government of Bangladesh which is a modified version of Multilingual Guide to freshness grade described by Howgate *et al*., (1992). Five members panel were constituted to evaluate the organoleptic quality changes of shrimp (*Penaeus monodon*) on the basis of odor, texture, color (with shell), color of flesh and general appearance of shrimp. The quality was evaluated by grading the shrimp using the score from 5 to 25. The grade defined in terms of the total number of points were: 22 to 25 considered as very good or excellent, 19-21 good, 14-18 acceptable, 8-13 bad and 5 to 7 very bad condition.

Biochemical Analysis

pH measurement

Two grams of peeled shrimps were homogenized with 10 ml distilled water in a blender and the pH was measured using a pH meter (Corning Model 250) for 30-60 seconds**.**

Total volatile base nitrogen (TVB-N) determination

Sample Preparation

Total volatile basic nitrogen (TVB-N) of the samples was determined according to the method described by the Official Journal of the European Communities (EC, 1995).

Determination of solubility and ATPase activity

Preparation of myofibrils

Myofibrils were prepared from muscles immediately after excision according to Perry and Grey (1956) with slight modification. The muscle was chopped by a meat grinder and chilled minced muscle (50g) was homogenized for 1 min in 5 volumes of 39mM borate buffer (pH 7.1) containing 25mM KCl and 0.1mM DTT. The homogenate was centrifuged for 15 min at 600 × g. The residue obtained was again homogenized and centrifuged for 15 min. The light-colored upper layer of the residue consisting of myofibril was recovered with small volume of 39mM borate buffer (pH 7.1) containing 0.1M KCl and 0.1mM DTT. The suspension was centrifuged for 15 min to remove the supernatant. Myofibrils were diluted with 4 volumes of 39mM borate buffer (pH 7.1) containing 0.1M KCl and 0.1mM DTT, and coarse materials were removed by centrifuging at 400 x g. The suspension was centrifuged again for 15 min at 600 X g to sediment myofibril. After the pellet was washed three times in the same way, myofibril were suspended with a desired volume of 39mM borate buffer (pH 7.1) containing 0.1M KCl to make a concentration of 10-15 mg/ml.

Solubility of myofibrillar proteins

Myofibrillar proteins were extracted from isolated myofibrils with 0.6M KCl-0.03 M Tris-HCl at pH 7.5. The suspension was stirred gently and kept over night at 4° C. Then the solution was centrifuged at 900x g for 30 min and protein content in the supernatant was determined by the biuret method (Gornall *et al*., 1949).

Assay of specific ATPase activity

The reaction mixture for the Ca^{2+}- ATPase assay contained 25mM Tris, 5mM $CaCl_2$, 0.1M or 0.5M KCl and 0.25 mg myofibril per ml. The reaction mixture for the Mg^{2+}-ATPase assay was prepared similarly as described before except further addition of 5mM $MgCl_2$. For EGTA modified Mg^{2+}-ATPase activity, 1mM EGTA solution was used instead of 0.5mM $CaCl_2$. The ATPase activity was measured at 25°C for 6 min. After preparation of the reaction mixture, an appropriate volume of myofibril suspension was pipetted to the reaction mixture followed by 2 min pre-incubation. The reaction was initiated by the addition of 1mM ATP and then 2 ml portion of the reaction mixture was withdrawn at different time intervals.

The reaction was stopped by adding1ml of 15% trichloroacetic acid. The supernatant obtained by 5min centrifugation at 3000 X g was analyzed for the liberation of inorganic phosphate (Pi) by a method described by Fiske and Subba Row (1925).

RESULTS AND DISCUSSION

Organoleptic changes in shrimp during handling and ice storage

Studies were conducted to evaluate the organoleptic quality of *P. monodon* obtained from farms, depots and processing plants (Fig. 1). According to freshness grade, initial samples obtained from farms, depots and processing plants were in excellent condition. The samples obtained from farms were in acceptable condition for 10 days in ice storage. This result is in agreement with that reported by Wai Lun Cheuk *et al.*, (1979). They studied the organoleptic quality of pink shrimp and brown shrimp based on the 'boil in bag' method. According to them the shrimp retained its prime quality up to 10 days after which there was a loss of the characteristics sweet flavor. From the 10^{th} to approximately 16^{th} day, the shrimp were still in acceptable quality, blunt in flavor but without pronounced off-odor or off-flavor. The result of the present study also coincides with that reported by Kodaria and Rojas (1996). They reported that the limit of acceptability for ice stored whole shrimp (*P. vanamei*) is approximately 10 days and that of beheaded shrimp 14 days. On the other hand, samples obtained from depots and processing plants were in acceptable condition for 7 and 6 days, respectively. These results indicate that quality loss of shrimp occurs at different stages of handling and transportation. The main reasons of quality loss of shrimp at various stages are probably related to rough handling and delayed icing after harvest.

Changes in pH value

Studies were also conducted on the change in pH of the shrimp obtained from various sources (Fig. 2). Initial pH of the shrimp at farm level was around pH 7 which decreased gradually during the first 2 days and then increased gradually with the lapse of storage periods. At the end of 10 days ice storage, the pH value reached to 7.36, which is slightly higher than the acceptable value of 7.25 (Kamal *et al.*, 2000). Bemmer *et al.*, (1994) reported that the mean pH value of shrimp tissue increased overall throughout of 16 days of storage. They also observed that the pH value of immediately treated shrimp ranged from 6.55 to 8.04, and for shrimp treated after 2 hours delayed, 6.40 to 8.04. The pH value of immediately treated shrimp ranged from 5.89 to 7.89 and shrimp treated after 2 hours delayed from 6.09 to 7.73. Although some significant differences in pH were found between treatment groups on a given day of storage, difference varied and showed no consistent pattern. In the present study, the pattern of changes in the pH values of shrimp samples obtained from farms was almost similar.

On the other hand, initial pH of the samples obtained from depot and processing plants were in the range of 6.52 to 6.83, which also continuously increased during the 10 days of storage. The pH value of the sample obtained from depot was within the acceptable range during the first 7days of storage. On the other hand, pH value of sample from processing plants reached beyond acceptable level during the 5 days of storage.

In the present study, it was observed that the initial pH value of the shrimp samples obtained from depots and processing plants were lower than the samples obtained from farms. This is perhaps due to some breakdown of glycogen to lactic acid that happened in depots and processing plants samples before sampling.

At the later stages of ice storage, the pH value of the samples obtained from farms, depots and industries gradually increased. The available reports suggest that this increase of pH value is due to the accumulation of basic nitrogenous compounds like TMA and ammonia generated due to microbial action. The results of this study support the already established fact that there is a good relationship between changes in pH and organoleptic qualities of shrimp, where the quality gradually decreased with the increase of pH. This study also shows that the pH value is a good indicator to assess the degree of freshness, and shrimp samples obtained from farms, depots and processing plants were initially in excellent to good condition.

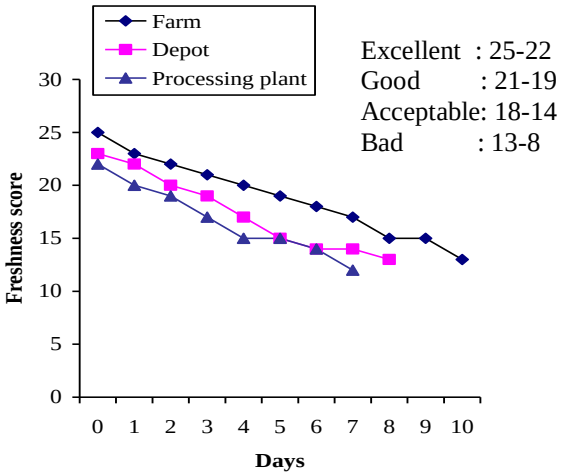

Fig. 1 Organoleptic changes in *P. monodon* during ice storage

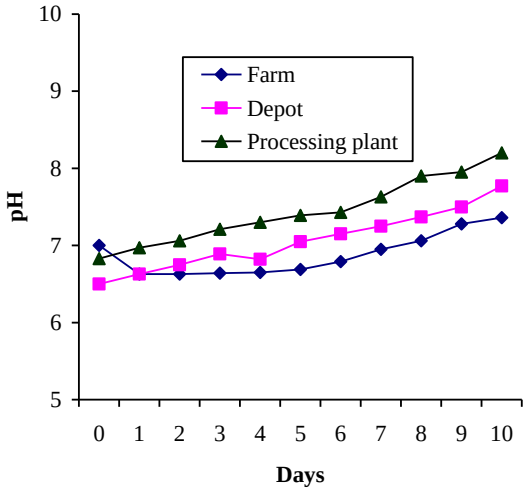

Fig. 2 Changes of pH value in *P. monodon* during ice storage

Changes in TVB-N

Analysis of TVB-N value is also an important indicator to assess the degree of freshness of fish and shellfish. Fig. 3 shows the changes in TVB-N values of *P. monodon* obtained from farm, depot, and processing plant. The initial TVB-N values were in the range of 6.14 to 7.84 for all the samples obtained from various sources, which continuously increased during ice storage. The TVB-N values of the samples obtained from farm immediately after harvest reached slightly beyond upper limit of 25 mg/100g after 9 days of ice storage. On the other hand, the TVB-N values of the samples obtained from depot and processing plant crossed the upper limit of 25mg/100 g after 7 and 6 days of storage, respectively. The TVB-N value of 25 mg/100g is recommended for import of marine products (Cobb *et al*., 1973; Reilly *et al*., 1984). A close relationship existed between TVB-N values and pH values where the values increased with storage period. Relationships between TVB-N values and organoleptic changes of shrimp during ice storage also observed where with the increase of TVB-N values the organoleptic score decreased.

Changes in solubility and ATPase activity

It was also important to see the quality changes of muscle protein during ice storage. Measurements of solubility and ATPase activities were carried out to assess the denaturation profile of myofibrillar protein during ice storage. As shown in Fig.4, initial myofibrillar protein solubility of *P. monodon* samples obtained from farm, depot and processing plant were above 80%, which gradually decreased with the increasing storage period. The decrease of solubility is markedly evident in samples obtained from depot and processing plant compared to those obtained from farm. As shown in the Fig. 4, at the end of the 10 days storage, protein solubility of the *P. monodon* myofibrillar protein of the samples obtained from farms decreased to 52% while the solubility of those obtained from depot and industry decreased to around 40% during the same storage period. These results indicate that there is a large fall of protein solubility in all samples during ice storage with maximum in samples obtained from depot or processing plant.

Studies were also conducted on the changes in myofibrillar ATPase activity of *P. monodon* samples obtained from various sources during ice storage (Fig. 5). The initial Ca^{2+}-ATPase activity of live *P. monodon* myofibrillar proteins was 0.721µmol-pi/min.mg,

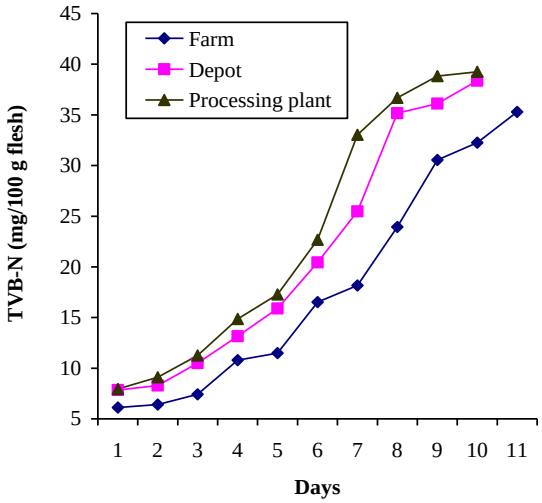

Figure 3. Changes in TVB-N of *P. monodon* during ice storage

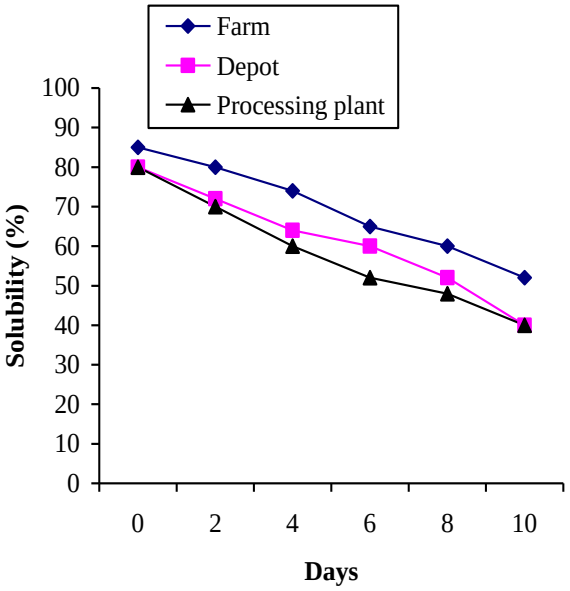

Figure 4. Changes of solubility of *P. monodon* during ice storage

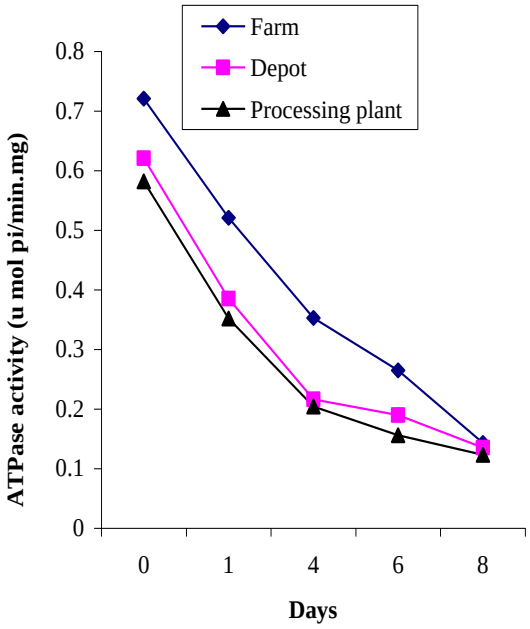

Figure 5. Changes of ATPase activities in *P. monodon* during ice storage

which declined rapidly during 10 days of ice storage. Similar result was also reported by Rahman *et al.*, (2001c). They reported that the Ca^{2+}-ATPase activity of *P. monodon* declined during 10 days of ice storage. The initial ATPase activity of the myofibrillar protein of *P. monodon* samples obtained from depot and processing plant were also declined rapidly during 8 days of ice storage. The rapid loss of ATPase activity was more evident in samples obtain from depot and processing plant compared to that obtained from the farm immediately after harvest. The large fall of ATPase activity of samples suggest the denaturation of myofibrillar protein during ice storage.

CONCLUSION

Considering the results of the present study it can be concluded that the overall quality management system of shrimp at farms, depots and processing plants are not well developed. Therefore, the workers involved at farms, depots and processing plants need adequate training on

quality management techniques of shrimp. Training programs are also required for farmers, suppliers and depot owners for implementation of HACCP at the field level for effective quality management. If possible a handbook on quality management system and HACCP should be prepared for field level training programs.

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