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Changes in organoleptic and biochemical parameters of three commercially important marine fish species of Bay of Bengal during ice storage

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ABSTRACT

The study was conducted to observe the changes in organoleptic and biochemical parameters of three marine fish species of Bay of Bengal during ice storage. The fish species, *viz.*, Bombay duck (*Harpadon nehereus*), silver jewfish (*Johnius argentatus*) and ribbon fish (*Trichiurus haumela*) were collected from the landing center of Cox's Bazar and frozen transported to Mymensingh city. After arrival in Mymensingh, the fish samples were stored in ice for about 9 days by applying fresh flakes of ice to the fishes at regular interval. During the storage period, required amount of fish samples were taken out from the ice box at two-day interval to collect data on changes in organoleptic and biochemical parameters (e.g., analysis of proximate composition, TVB-N and pH). During ice storage, the overall organoleptic qualities of all fish samples were in acceptable condition up to 9 days. The fish samples stored in ice exhibited excellent quality on the basis of physical characteristics until 3rd day of storage. Biochemical analyses revealed that the percent moisture content of Bombay duck, silver jewfish and ribbon fish increased with the lapse of storage period whereas the percent protein content decreased With the progress in storage period. Lipid content also decreased gradually in the same samples but the percent ash content of the samples changed very little. The values for total volatile base nitrogen (TVB-N) of the three fish samples increased slightly during the storage period. The pH value of the fish samples also increased throughout the storage. So, the present study conclude that the organoleptic characteristics and biochemical parameters of above mentioned fish changes during ice storage of 9 days but found acceptable for human consumption.

Keywords: Organoleptic quality, biochemical parameters, marine fish, ice storage

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1 Introduction

Bangladesh is bounded on the south by the Bay of Bengal. The coastline of Bangladesh is about 710 km long and the continental self extends over an area of about 24,800 nmi^2 of which about 37,000 km^2 is within 50 m depth zone and have good fish resources. Oceans currents in the Bay of Bengal are complicated because the Bay is rather narrow in the north and flanked by coasts in three directions (east, north and west) and many rivers flow in it. The effective area of marine fishery ground is estimated to be around 10,000 km^2 (Ahsan, 2013). According to the survey reports of Bangladesh Fisheries Development Corporation (Hussain, 1971) over 40 species of sea fish have been identified as commercially important for Bangladesh. Among these 40 species of fishes, three species, namely, Bombay duck (*Harpadon nehereus*), silver jewfish (*Johnius argentatus*) and ribbon fish (*Trichiurus haumela*) are very important for this country (Rahman, 1989, 2005). In Bangladesh both fresh and dried fishes are very popular as food item. According to Rupsankar (2010) the demand of fresh marine fish is limited traditionally and major part of the landed fishes are converted to rope dried product.

It is having esteemed as food particularly in Chittagong (Bangladesh) where these are found in abundance (Rahman, 1989, 2005) and in South, Southeast Asia, dried Bombay-duck is having commercial importance. In the Hooghly estuary (West Bengal), India, this fish contributes a substantial fishery (Talwar and Jhingran, 1991). Rupsankar (2010) reported that Bombay duck has high moisture content (89%) and high enzymatic and bacteriological activity. Shankar et al. (2008) reported the low fat content of this fish species. Several reporters (Koffi-Nevr et al., 2011; Sutharshin and Sivashanth, 2011) stated that- for human being marine fish serves as a source of energy as they contain most important nutritional components. Khan and Khan (2001) reported that for consumption of mass people at the scarcity of fresh fishes in Bangladesh, about 15% of fishes are cured. On the other hand, icing is also one of the most popular methods of storage of marine fish. During chilling ice play very important role. The high latent heat of ice removes large amount of heat from the adjacent substance and melts keeping the temperature unchanged at 0 °C. To bring temperature from 30 °C to 0 °C of 3 kg fish, 1 kg ice is enough. Even after cooling the fish, to avoid absorbing heat from environment sufficient ice is needed around the fish until future action. Though in temperate region a 3:1 fish to ice ratio is sufficient (FAO, 2019) but for tropical region the ideal ratio is 1:1.

Since spoilage is influenced by temperature so as soon as possible the temperature of fish should be lowered. During icing just the proper ratio of fish to ice is not enough, it is necessary to ensure the dispersion of ice among the fish. Smaller sized ice or flack ice is more effective to cool down the fish than the ice of bigger size. Smaller sized ice can be spread to the fish body surface homogeneously avoiding any physical damage. Many researchers worked on the storage of different species in lower temperature, specially in ice. The shelf life of fishes in iced condition varies due to different reasons, such as species, age, sex, habitat, degree of exhaustion etc. In case of ice storage, some changes occur in the nutritional composition of fishes as water soluble proteins, salt and other nutritional substances drain out from fish body with the melting ice water. Though icing extends the shelf life of stored fish but the ultimate purpose of icing is to keep the fishes in acceptable condition to the consumers.

Considering the above mentioned facts this work was undertaken to study determine the effects of ice storage on the quality aspects of Bombay duck (*H. nehereus*), silver jewfish (*J. argentatus*) and ribbon fish (*T. haumela*) in terms of changes in organoleptic and biochemical characteristics changes for 9-day period.

2 Materials and Methods

2.1 Collection and transportation of fish

For this experiment three marine fish species, Bombay duck, silver jewfish and ribbon fish were bought directly from the 'Arotder' (wholesale suppliers) of the landing center in Cox's Bazar. According to the information obtained from the relevant persons there, the fishes were caught by gill net and was iced immediately after the catch. The iced fishes (10 fishes of each species) were then brought to the BFDC (Bangladesh Fisheries Development Corporation) landing center of Cox's Bazar. The average length of collected Bombay duck, silver jewfish and ribbon fish were 18.50 cm, 19 cm and 32.28 cm, respectively and average body weight were 255 g, 530 g and 565 g, respectively (Fig. 2). The collected fishes were kept in ice box using flake ice where the ratio of ice: fish was 1: 1. The transportation of fishes in ice box took a 15-hour bus journey from Cox's Bazar to Mymensigh.

2.2 Storage experiment

Since the experimental fishes were collected from long distance the iced fishes were first transported to the Marine Fisheries Technology Station Laboratory of Bangladesh Fisheries Research Institute (BFRI), Cox's Bazar for freezing. The iced fishes were put into a freezer for freezing. After the completion of freezing, the fishes were packed in polythene pack and kept in insulated ice box. The insulated ice box with frozen fishes was finally transported to Fish Processing Laboratory, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh. Then the frozen fishes were transferred to another ice box and flake ice was spread over the fishes maintaining 1:1 fish to ice ratio for further studies. Flake ice of ice box was changed in regular basis after a certain interval of time to ensure proper insulation.

2.3 Organoleptic assessment

Organoleptic assessment of the experimental fishes were done following the guidelines and methods

Figure 1. (a) Bombay duck (*Harpadon nehereus*), (b) Silver jewfish (*Johnius argentatus*), and (c) Ribbon fish (*Trichiurus haumela*)

as described by EC freshness grade for fish quality (Howgate et al., 1992) as presented in Table 1. The following formula was used for organoleptic assessment of the fishes:

$$AGP = \frac{TGP}{N_c} \quad (1)$$

AGP = average grade points, TGP = total grade point, N_c = number of characters.

2.4 Sampling procedure

Sampling of the iced fishes were done at every 2nd day until the end of the experiment. For different studies, 2 to 3 fishes were taken from each species. The iced fishes were first thawed in running tap water and then water on fish skin (i.e. surface) was soaked with kitchen tissues. Required amount of fish muscle was collected from fish, chopped on a clean chopping board with sharp knife and then blending was done for homogeneous mixing.

2.5 Proximate composition analysis

Biochemical analyses of the samples were done according to AOAC (1980) method with certain modifications in the Fish Processing Laboratory, Department of Fisheries Technology, BAU.

2.6 Total volatile base-N (TVB-N)

Total volatile base-nitrogen (TVB-N) of fish samples was also determined by AOAC (1980) method with certain modification.

2.7 pH Measurement

For pH measurement, 2 g of fish muscle sample was blended in 10 mL of distilled water and value was measured using a pH meter (Corning Model 250).

3 Results

Changes in organoleptic characteristics and proximate composition of three species of ice stored fishes were studied. At the same time changes in TVB-N and pH values were also observed at definite time interval throughout the storage period in ice.

3.1 Changes in organoleptic characteristics

The results of changes in the organoleptic characteristics of three fish species, namely, Bombay duck, silver jewfish and ribbon fish during 9 days of storage in ice are presented in Table 2. Quality deterioration in the ice stored fishes were graded according to grade scoring method (Table 2) using the score from 1 to 5. In terms of the total number of defects or demerit points, the grades of iced fishes were defined. The fishes were considered excellent while their score was less than 2; good or acceptable with the score from 2 to less than 5 and bad or rejected with the score 5 and above. Results of the observations on organoleptic characteristics of experimental fishes are presented in Table 2. The fishes were in acceptable condition up to 9 days of storage in ice. On the basis of organoleptic characteristics, fishes exhibited excellent quality until 3rd day of storage in ice. The color of the fishes were slightly silvery to whitish which exhibited excellent color. Texture was firm-flexible and odor also was quite natural. The color, flavor, texture are the important factors to influence the overall acceptability of fishes by consumers. The organoleptic assessment revealed that all the fishes were acceptable up to 9 days in ice though the grade points increased with lapse of storage period indicating continuous quality deterioration of the fishes.

3.2 Changes in biochemical parameters

The results of changes in biochemical parameters i.e., changes in percent moisture, protein, lipid and ash

Table 1. Determination of defect points and grading system of fresh fish

Characteristics	Defect characteristics	DP †	Freshness ‡
Odor of neck when broken	(a) Natural fishy odor	2	Good
Odor of gill	(a) Natural odor	1	Excellent
	(b) Faint sour odor	2	Good
	(c) Slight moderate sour odor	3	Good
Color of gill	(a) Slight pinkish red	1	Excellent
	(b) Pinkish or brownish red, mucus may be present	2	Good
	(c) Brown or gray color covered with mucus	3	Good
General appearance	(a) Full bloom, bright shining iridescent	1	Excellent
	(b) Slight dullness loss of bloom	2	Good
Eye	(a) Bulging with protruding lens; transparent eye cap	1	Excellent
	(b) Slight clouding of lens and sunken	2	Good
	(c) Dull, sunken, cloudy	5	Bad
Slime	(a) Usually clear, transparent and uniformly spread but occasionally may be slightly opaque or milky	1	Good
	(b) Becoming turbid opaque and milky amount of slime present in skin	1	Good
	(c) Thick, sticky, yellowish greenish in color	5	Bad
Consistency of flesh	(a) Firm, elastic	1	Good
	(b) Moderately soft and someloss of elasticity	2	Good
	(c) Some softening	3	Good

† DP = Defect points; ‡ DP <2 = Grade A (acceptable), DP 2∼<5 = Grade B (acceptable), and DP 5 = Grade C (rejected)

Table 2. Changes in physical characteristics of Bombay duck (*Harpodon nehereus*), silver jewfish (*Johnius argentatus*) and ribbon fish (*Trichiurus haumela*) during ice storage

Days of storage	Organoleptic quality	Point	Overall quality
0	Natural fishy odor; bright red gill; full bloom, bright and shining; transparent eye cap; firm and elastic flesh	1.25 – 1.52	Excellent
1	Natural fishy odor; bright red gill; full bloom, bright, shining; transparent eye cap; firm and elastic flesh	1.57 – 1.71	Excellent
3	Natural fishy odor; red gill, bright and shining; transparent eye cap; elastic flesh	1.71 – 1.86	Excellent
5	Natural odor; slightly pinkish gill; bright and shining appearance; slightly plane eye cap; some lose of elasticity flesh	2.01 – 2.33	Acceptable
7	Moderate sour odor; pink gill; slightly dullness and loss of bloom; slightly cloudy lens and sunken eye cap; some softening of flesh	2.85 – 3.14	Acceptable
9	Sour odor; brown gill; loss of bloom; cloudy lens and sunken eye cap; some softening of flesh	3.42 – 3.57	Acceptable

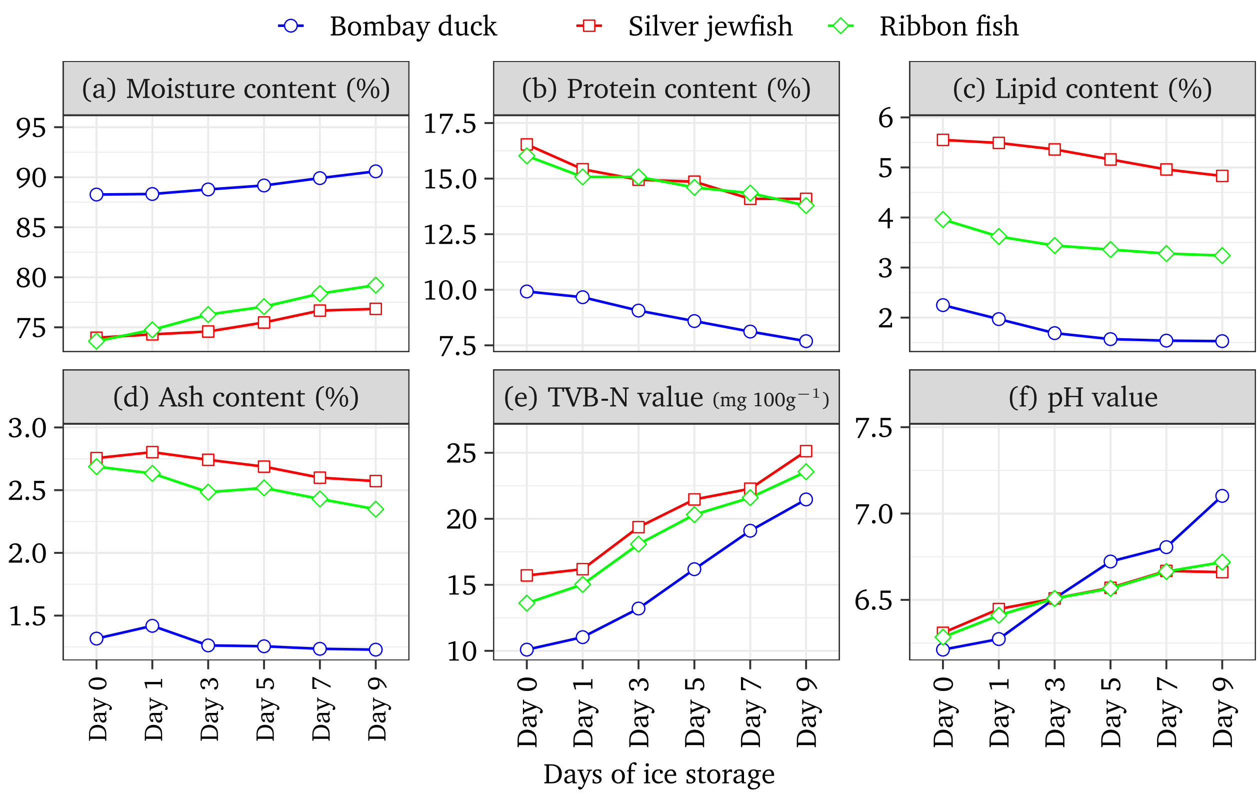

Figure 2. Changes in biochemical parameters of three marine fishes during ice storage

(in wet weight basis) content, TVB-N and pH values in three experimental fishes are shown in Fig. 2.

Moisture content The moisture content ranged from 88.51% to 90.65% in Bombay duck, 73.98 to 76.95% in silver jewfish and 73.68% to 79.36% in ribbon fish (Fig. 2a). Moisture content was lowest in ribbon fish (73.68%) and highest in Bombay duck (90.65%) (Fig. 2a).

Protein content The protein content of all three species of ice stored fishes decreased gradually with the lapse of time. Protein content of Bombay duck, silver jewfish and ribbon fish ranged from 9.88% to 7.72%, 16.54% to 14.12% and 16.03% to 13.94%, respectively (Figure 2). The lowest value obtained for Bombay duck 7.72% and the highest value obtained for silver jewfish 16.54% (Fig. 2b).

Lipid content In this study percent lipid content in the ice stored fishes also decreased gradually. In case of Bombay duck lipid content ranged from 2.25% to 1.53%, in silver jewfish from 5.55% to 4.83% and in ribbon fish from 3.96% to 3.24% (Fig. 2c). The lowest value obtained for Bombay duck 1.53% and the highest value for silver jewfish 5.55% (Fig. 2c).

Ash content The percent ash content in all three species of fishes increased with progress in storage period. The ash content in Bombay duck ranged from 1.23% to 1.43%, in silver jewfish from 2.58% to 2.81% and in ribbon fish from 2.36% to 2.70% (Fig. 2d). The lowest ash content was found in Bombay duck 1.23% and the highest in Silver jewfish 2.81% (Fig. 2d).

TVB-N value TVB-N value changed with the lapse of time in all fishes (Fig. 2e). The TVB-N value ranged from 10.38 to 21.52 mg $100g^{-1}$ in Bombay duck, from 15.72 to 25.36 mg $100g^{-1}$ in silver jewfish and from 13.74 to 23.85 mg $100g^{-1}$ in ribbon fish. The lowest TVB-N value was reported for Bombay duck 10.38 mg $100g^{-1}$ and the highest value for silver jewfish 25.36 mg $100g^{-1}$ (Fig. 2e).

pH value During the ice storage, the pH value of the samples increased gradually (Fig. 2f). The pH value increased from 6.2 to 7.1 in Bombay duck, from 6.32 to 6.67 in silver jewfish and from 6.3 to 6.72 in ribbon fish. The lowest and the highest pH values were obtained for Bombay duck which ranged from 6.2 to 7.10 (Fig. 2f).

4 Discussion

It is well known that the proximate composition of fishes dependent on some factors like sex, size, physical condition, habitat, degree of exhaustion during catching, season, location of catch etc. The sample fishes used in this experiment were caught in different time, catch of location and physical condition was not similar as done in the previous studies. The results obtained in this study for three marine species of fish in ice are quite similar to the findings of Shreni (1980), Reza et al. (2006) and Reza et al. (2009). Shreni (1980) reported an inverse relationship between moisture and fat content in tissue, muscle and liver. The inverse relationship was more pronounced in liver of fish between moisture and fat than in muscle. They also reported the variation in moisture content in male and female fishes of the same species in a year which ranged from about 75% to 80% in males and 71% to 82% in females. Thus in the annual moisture cycles of male and female fishes of their study, two peaks of fat accumulation corresponded with two distinct minima of moisture observed. Reza et al. (2006) carried out a study on the changes in moisture content of some marine fishes namely silver jewfish, Bombay duck, bigeye tuna, Chinese pomfret and ribbon fishes in ice stored condition. They observed a continuous increasing trend in moisture content with the lapse of storage time. They reported the range of gradual increment in the moisture contents as 70.5% to 89.1% for silver jewfish, 71.7% to 90.5% for Bombay duck and 72.1% to 90.7% for bigeye tuna during 13 days of storage in ice. Reza et al. (2009) also carried out a similar type of study and reported the moisture content of five marine fishes namely, silver jewfish, Bombay duck, bigeye tuna, Chinese pomfret and ribbon fish. They found that the moisture content increased gradually and it ranged from 73.47% to 78.69%, 89.10% to 90.7%, 71.25% to 74.44%, 70.54% to 72.15% and 72.0% to 80.0%, respectively for the fish samples.

Shreni (1980) and Reza et al. (2009) also found almost similar results for changes in percent protein content in some ice stored marine species of fishes. A study carried out on the seasonal fluctuation in protein contents in fish in a year by Shreni (1980) reported the range of variations from 11% to 19%, approximately. The lowest protein percent in the muscle of female fish was found in October, then gradually increased and the maximum value was obtained in November. On the other hand in case of ice storage of five marine species of fishes, a gradual decrease in percent protein content was reported by Reza et al. (2009). They observed that- the protein content decreased from 16.30% to 12.10% in silver jewfish, 8.96% to 7.20% in Bombay duck, 19.90% to 17.82% in bigeye tuna, 17.20% to 16.91% in Chinese pomfret and 11.70% - 10.12% in ribbon fish.

Shreni (1980) carried out a study on the seasonal variation in fat content in muscle and liver of *Heteropneustes fossilis*. They observed two peaks in muscle fat content of this fish during November and May though the accumulation of fat content in female fish was found for an extended period (May to July). In case of liver fat content, these two peaks were observed at April–June and September after which started to decrease and the lowest value obtained in December. Fat content was relatively higher in female fishes than male fishes in most of the cases. During the winter months (January to March) the fat content obtained higher values than other seasons both in muscle and liver of fishes. Reports on fat content of some air breathing fishes of Bangladesh stating the range 2.18% to 9.38% (Rahman et al., 1982, 1984). A study on the changes in fat content of five marine species of fishes in 13 days of ice storage performed by Reza et al. (2009) showed the ranges from 6.0% to 5.86% for silver jewfish, from 1.10% to 0.8% for Bombay duck, from 6.70% to 4.60% for bigeye tuna, from 6.0% to 5.66% for Chinese pomfret and from 6.0%-5.50% for ribbon fish. All These findings are very much similar to the values obtained in the present study. A range of ash content from 9.98% to 4.56% in dry fishes was reported by Gheyasuddin et al. (1977). Bhuiyan (1992) also found the range of ash content in dry fishes from 6.6% to 16.2%.

In three marine dried fishes (*Harpodon nehereus*, *Johnius dussumieri* and *Lepturacanthus savala*) fat content varied between 7.56% to 4.76%, 6.37% to 4.89% and 4.86% to 4.64%, respectively, according to the observation of Siddique and Aktar (2011). During ice storage of 13 d of five marine fishes the fat content gradually increased and ranged from 2.97% to 3.35% in silver jewfish, 0.85% to 1.30% in Bombay duck, 2.85% to 3.14% in bigeye tuna, 3.27% to 3.42% in Chinese pomfret and 2.67% to 2.88% in ribbon fish as Reza et al. (2009) reported. These findings coincide well with the findings of the present study.

Kose and Erdem (2001) carried out a study on the quality changes of whiting (*Merlangius merlangus* euxinus, N. 1840) stored at ambient and refrigerated temperatures and found the lowest and highest TVB-N values for ambient temperatures were 12.6 and 47.2 mg $100g^{-1}$ at the 1st and 3rd days of storage, respectively. At the end of the 1st day of storage, the lowest TVB-N value for the refrigerator was determined as 8.2 mg $100g^{-1}$ for the 3rd batch and the highest value was 44.6 mg $100g^{-1}$ on the 5th day of storage. By comparison with ambient temperatures, the highest TVB-N value was 30.4 mg 100 g^{-1} on the 3rd day of storage for the refrigerated samples. The variations between batches were not found to be significant except between some of the batches on the 2nd day of storage for both temperatures. Ocaño-Higuera et al. (2011) carried out an experiment on freshness assessment of ray fish stored in ice by biochemical,

chemical and physical methods. The result of their experiment showed that regarding to the signs of freshness and deterioration, *K* value presented an exponential increase($r^2 = 0.95$) with an initial value of 4.7% and a final value of 47.5%. Furthermore, the TBV-N and TMA-N significantly increased ($p<0.05$) during the storage in ice. Similar increasing trend in TVB-N content with the lapse of time was found even for the ice stored marine fishes in the present study.

During ice storage of 13 d, pH value ranged within 7.2 and 7.98 for five marine species of fishes namely silver jewfish, Bombay duck, bigeye tuna, Chinese pomfret and ribbon fish as Reza et al. (2009) reported. According to their observation, pH gradually increased with the lapse of storage time and at the end of storage the value reached to 7.98. Among the five species of fishes, the lowest value 7.2 was found for ribbon fish and the highest value 7.98 was found for bigeye tuna. The low pH value at the initial stage of storage might be due to the formation of lactic acid during anaerobic glycolysis in fish muscle. Then a gradual increase in pH value at the later phase of ice storage indicates the accumulation of alkaline compounds, such as ammonia compounds and TMA, mainly derived from microbial action ((Hebard et al., 1982)). These results are quite similar to the findings of the present study.

5 Conclusions

Taking in account the safety issues, it could be recommended that these three marine fish species can be stored in ice up to 9 d as these fishes were in acceptable condition until 9th day without any prominent deterioration of the quality or loss in the nutrients and hence, remain good for human consumption.

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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