



Studies on the Quality and Safety Aspects of Giant Tiger Prawn (*Macrobrachium rosenbergii*) and Bombay Duck (*Harpodon nehereus*) of the Bay of Bengal along the Cox's Bazar Coast of Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Author MAH designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors PC and AAI managed the analyses of the study. Author PC managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The quality and safety aspects of two commercially important species *Macrobrachium rosenbergii* and *Harpodon nehereus* were evaluated on this study by examining organoleptic properties, proximate composition, total volatile base-nitrogen (TVB-N) and tri methyl amine-nitrogen (TMA-N) contents of the samples. Both the species showed excellent sensory quality with the defect point 1.57 and 1.4 for *M. rosenbergii* and *H. nehereus*, respectively. The moisture content of *M. rosenbergii* and *H. nehereus* were 80.89±0.23% and 78.56±0.39%; the protein content were 11.76±0.3% and 13.74±0.04%; the lipid content were 2.15±0.007% and 1.89±0.34% and the ash content were 1.24±0.35% and 1.97±0.31% respectively. The TVB-N and TMA-N was found 19.3±0.45 mg/100 g and 3.19±0 mg/100g for *M. rosenbergii* and 22.37±0.15 mg/100g and 2.09±0.04 mg/100 g for *H. nehereus* respectively. The result showed the nutritional composition and quality attributes of these two species.

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1. INTRODUCTION

Fish and seafood are important part of a healthy diet and are considered as the biggest source of protein [1]. In recent years, consumption of seafood products has risen dramatically. By composition, fish contain fat, free amino acids and water which is susceptible to spoilage by microorganisms and biochemical reactions during post mortem process [2,3]. However, along with the growth in consumption, there has been growing enthusiasm for efforts to improve the quality and the perceived safety of seafood items. Finfish are generally regarded as being much more perishable than other high-protein muscle foods. This high degree of perishability is due primarily to the large concentration of nonprotein nitrogenous compounds present in fish muscle.

Fish plays an important role in the Bangladeshi diet, it constituting only animal protein source among rural households [4,5,6]. There are 260 indigenous, 24 exotic fish species and 24 species of prawn and also 475 species of marine fish [7] available so far in the waters of Bangladesh. Now aquaculture plays a vital role to fulfill our domestic demand of protein and also we earn a lot of foreign exchange by exporting fishes and fisheries product. Fish alone supplies about 60 percent of animal protein and about 10.5 million people are directly or indirectly earn their livelihood out of activity related to fisheries [8]. Fisheries resources have great contribution in the economy of Bangladesh accounting for about 4.39% of GDP. About 2.46% of annual export earning comes from the fisheries sector and it ranks 3rd among the export oriented industries [9].

Aquaculture represents the second largest export industry for Bangladesh after garments with 97% of the shrimp produced being exported [10] and employing approximately 1.2 million people for production, processing and marketing activities. Including their families, this seems approximately 4.8 million Bangladeshi people directly dependent on this sector for their livelihood [11].

Foods from the aquatic environment are a unique source of the essential nutrients. Fish meat is basically composed of water (66-81%), protein (16-21%), carbohydrates (<0.5%), lipids (0.2-25%) and ash (1.2 to 1.5%) [12]; and is considered to have important biological value

due to the contribution of essential amino acids (Hatae et al. 1990) and micronutrients [13], as well as, its high levels of fatty acids omega-3 and omega-6, higher than in most meat sold for human consumption [14]. Fish serves as a health-food for the affluent world owing to the fish oils which are rich in polyunsaturated fatty acids (PUFAs), especially ω -3 PUFAs and at the same time, it is a health-food for the people in the other extreme of the nutritional scale owing to its proteins, oils, vitamins and minerals and the benefits associated with the consumption of small indigenous fishes [15].

The study is conducted to evaluate the nutritional quality of high valued giant freshwater prawn (*Macrobrachium rosenbergii*) and most landing marine fish *Harpodon nehereus*. It is important to know the proximate composition of these two species on the context of Bangladesh, because the fast growing food processing industries make these fish items on their hotlist.

The measurement of proximate composition such as moisture, protein, lipid, ash and fibre content in fish is often necessary to ensure that they meet the requirements of food regulations in nutrition aspects and commercial specifications [16]. The assessment of the proximate composition of the fish is not only important to know its nutritive value, but also for its better processing and preservation [17]. The percentage of water is good indicator of its relative contents of energy, proteins and lipids. Carbohydrates and non-protein compounds are also important constituents but are present in small amounts and are usually ignored during analysis. Proximate composition is used as an indicator of fish quality; it varies with diet, feed rate, genetic strain and age [18]. The nutritional composition of fish varies greatly from one species and individual to another, depending on age, feed intake, physical activity, sex and sexual changes connected with spawning, the environment or geographical localities and season [19]. Furthermore, the variations in proximate composition of fish are closely related to the feed intake and the water where they live. The processor, the nutritionist, the cook and the consumer all have a direct interest in the composition of fish in order to know the nature of the raw material before chilling, freezing, smoking or canning can be correctly applied [12]. Consumers have often wanted to know if there are nutritional differences in various fish species

from different sources. This can only be answered through the proximate analysis of various fish species from different sources. On the other hand information required about the biochemical features of the species for processing operations in the food industries.

In the present study, attempts have been made to collect data will be helpful in preparing a commodity satisfying the quality requirements and safety aspects. The annual landing of these two species are increasing steadily with higher potential in coming years. The present study was undertaken to determine the quality and safety aspects of *M. rosenbergii* and *H. nehereus* by determining physical and organoleptic

observation and to analyze the proximate composition of *M. rosenbergii* and *H. nehereus* for evaluating their nutritional quality.

2. MATERIALS AND METHODS

The study had been undertaken and completed according to the following order of methodology (Fig. 1).

2.1 Duration of the Study

The present study was conducted during the months of January-May 2016. The study was carried out inside the laboratory of Bangladesh Agricultural University, Mymensingh.

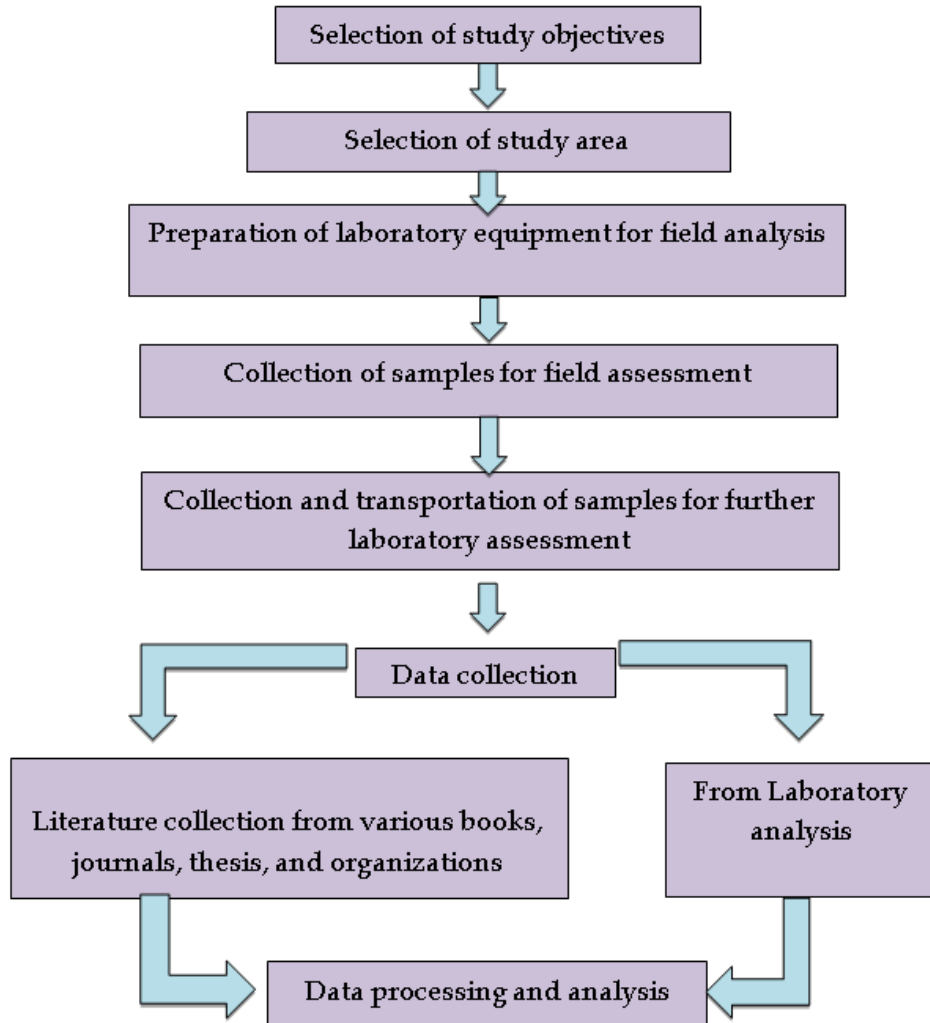


Fig. 1. Design of the research methodology

2.2 Collection of Sample

Fresh samples of *M. rosenbergii* and *H. nehereus* were collected from fish market located in the Cox's Bazar region.

2.3 Transportation and Storage of Experimental Material

Collected samples were preserved in ice-insulated box immediately after collection to transport from Cox's Bazar to Bangladesh Agricultural University campus and further preserved in freezer by packing individually inside the laboratory at around -20°C temperature.

2.4 Physical Characteristics

The guidelines and methods given here using score on the organoleptic characteristics of fish

as described by EC freshness grade for fishery products which is shown in (Tables 1 and 2).

Table 1. Grading of fresh fish

Grade	Points	Degree of freshness
A	<2	Excellent/Acceptable
B	2 to <5	Good/Acceptable
C	5	Reject

Calculation of organoleptic assessment

$$SDP = \frac{\sum DP}{n}$$

Here,

SDP=Score of defect point

∑ DP= Summation of defect point

n= Number of characters

Table 2. Determination of defect points

Characteristics of whole fish	Defect characteristics	Defect point	Grade
1) Odour at neck when broken	a) Natural odour	1	Acceptable
	b) Faint sour odour	5	Rejected
2) Odour of gills	a) Natural odour	1	Excellent
	b) Faint sour odour	2	Acceptable
	c) Slight moderate sour odour	3	Acceptable
	d) Moderate to strong sour odour	5	Rejected
3) Colour of gills	a) Slight pinkish red	1	Excellent
	b) Pinkish red or brownish	2	Acceptable
	c) Brown or grey colour	3	Acceptable
	d) Bleached; thick yellow slime	5	Rejected
4) General appearance	a) Full bloom; bright, shining; iridescent	1	Excellent
	b) Slight dullness and loss of bloom	2	Acceptable
	c) Definite dullness and loss of bloom	3	Acceptable
	d) Reddish lateral line; dull, no bloom	5	Rejected
5) Slime	a) Usually clear, transparent and uniformly spread	1	Excellent
	b) Becoming turbid, opaque and milky	2	Acceptable
	c) Thick, sticky, yellowish or green in colour	5	Rejected
6) Eyes	a) Bulging with protruding lens; transparent eye cap	1	Excellent
	b) Slight cloudy of lens and sunken	2	Acceptable
	c) Dull, sunken, cloudy	3	Acceptable
	d) Sunken eye covered with yellow slime	5	Rejected
7) Consistency of flesh	a) Firm and elastic	1	Excellent
	b) Moderately soft and loss of elasticity	2	Acceptable
	c) Some softening	3	Acceptable
	d) Limp and floppy	5	Rejected

2.5 Proximate Composition

AOAC [20] method was followed for proximate composition of the sun dried fish products. Homogeneity of the samples was done by using a blender. All the determinations were made in duplicate or in triplicate. Prior to analysis the dried fishes without any pretreatment were first chopped with large knife in order to make into small pieces.

2.5.1 Moisture

Moisture was determined by placing an accurately weighed known amount of ground sample in a pre-weighed porcelain crucible in an electric oven at 105°C for about 24 hours until constant weight was obtained. The loss of moisture was calculated as percent moisture.

$$\text{Moisture content (\%)} = \frac{\text{Weight of wet material} - \text{Weight of dry material}}{\text{Weight of wet material}} \times 100$$

2.5.2 Ash

About 3-5g prepared sample was taken in pre-weighed porcelain crucible and was placed in muffle furnace at 550°C for 6 hours. Then the crucibles were cooled in desiccators. The average in percentage of each sample of the remaining materials was taken as ash.

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

2.5.3 Crude protein

Kjeldhal method was used to determine protein content of the dried fish samples. Total nitrogen was calculated by using the following formula-

$$\text{Nitrogen (\%)} = (\text{ml. Acid titrated} \times \text{normality of acid titrated} \times \text{milli equivalent of N (0.014)}) / (\text{Weight of sample}) \times 100$$

$$\% \text{ of crude protein} = \text{Nitrogen\%} \times 6.25$$

2.5.4 Lipid

Lipid content was determined by soxhlet apparatus using acetone as solvent. The calculated value for lipid content was obtained as percent sample.

$$\text{Lipid content (\%)} = \frac{\text{Weight of lipid}}{\text{Weight of sample}} \times 100$$

2.6 Total Volatile Base-Nitrogen (TVB-N)

Total Volatile Base-Nitrogen (TVB-N) was determined by standard method in Laboratory.

Calculate the total volatile base nitrogen content of the sample from the expression-

$$\text{Total Volatile Base Nitrogen (mg per 100 g)} = \frac{\{14(300+W) \times V\}}{500}$$

Where V = volume of standard acid consumed, as indicated first back-titration and W = water content of sample expressed as mg per 100 g.

2.7 Tri Methyl Amine Nitrogen (TMA-N)

Tri Methyl Amine Nitrogen (TMA-N) was determined by standard method in Laboratory.

Calculate the trimethylamine nitrogen content of the sample from the expression-

$$\text{Trimethylamine Nitrogen (mg per 100g)} = \frac{\{14(300+w) \times V\}}{500}$$

Where Vml = volume of standard acid consumed, as indicated first back-titration and W = water content of sample expressed as mg per 100 g

3. RESULTS

Studies were conducted on assessing sensory quality, proximate composition, TVB-N and TMA-N content of giant freshwater prawn (*Macrobrachium rosenbergii*) and bombay duck (*Harpodon nehereus*) to analyze the quality and safety aspects of these two species. The results of this study are presented and discussed on this chapter.

3.1 Sensory Quality Evaluation of *M. rosenbergii* and *H. nehereus*

The result of sensory assessment was presented in Table 3.

3.2 Proximate Composition of *M. rosenbergii* and *H. nehereus*

Moisture, protein, lipid and ash contents were estimated to analyze the proximate composition of these two species. The results were illustrated in Table 4, Figs. 2 and 3.

Table 3. Organoleptic characteristics of *M. rosenbergii* and *H. nehereus*

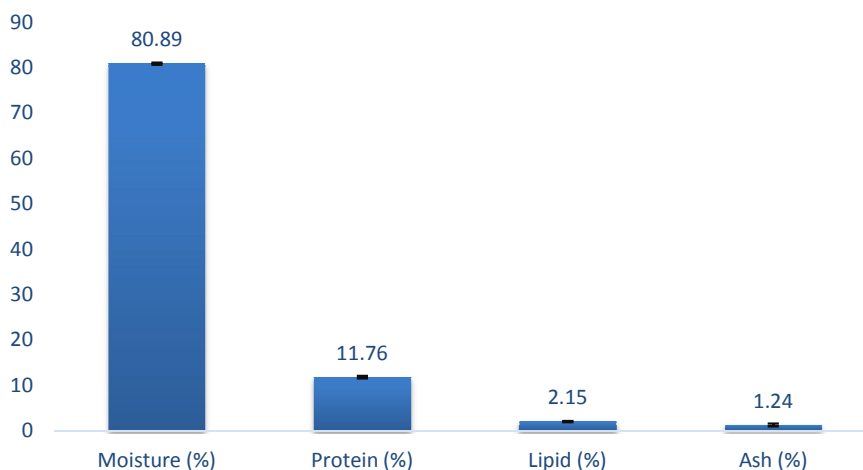
Fish species	Organoleptic quality (Physical characteristics)	Defect point	Overall quality
<i>M. rosenbergii</i>	Fresh, bright, shining and iridescent, firm, consistent and elastic texture with characteristics of white color of flesh. Neutral odor and color of shell.	1.57	Excellent
<i>H. nehereus</i>	Fresh, bright appearance, soft and firm and elastic texture with characteristics fresh odor	1.40	Excellent

Table 4. Proximate composition of *M. rosenbergii* and *H. nehereus* samples

Species	Moisture (%)	Crude Protein (%)	Crude Lipid (%)	Ash (%)
Prawn	80.89±0.23	11.76±0.3	2.15±0.007	1.24±0.35
Bombay Duck	78.56±0.39	13.74±0.04	1.89±0.34	1.97±0.31

*Values are mean ± SD of individual replications of sample

Proximate Composition of *M. rosenbergii*

**Fig. 2. Moisture, protein, lipid and ash percentage of *M. rosenbergii***

3.3 TVB-N and TMA-N Values of *M. rosenbergii* and *H. nehereus*

The result of TVB-N and TMA-N values was presented in Table 5.

4. DISCUSSION

4.1 Sensory Quality Evaluation

Both fish sample were found in acceptable as well as excellent physical condition. Defect points were found 1.57 and 1.4 for *M. rosenbergii* and *H. nehereus* respectively. Kamal et al. [21] studied organoleptic characteristics of both *M. rosenbergii* and *Penaeus monodon* and found in organoleptically acceptable condition for 6 to 7 days under iced storage. In similar findings,

Rahman [22] also reported that the fresh shrimp samples stored in ice immediately after harvest were started to lose natural flavor after 3 to 4 days and remained organoleptically acceptable for 10 days. Haque et al. [23] found excellent organoleptic condition after storage of Bombay duck (*Harpodon nehereus*).

4.2 Moisture Content

The moisture content of prawn (*M. rosenbergii*) sample was estimated 80.89±0.23% from three different measurements. Begum et al. [24] found 78.67% moisture content initially while studying *M. rosenbergii*, which is nearly similar to the findings of our present study. Chanmugamet al. [25] studied nutritive composition of 18 species of frozen shrimp including *M. rosenbergii* and

moisture content was found from 72.8 to 81.9% during the study period. So the findings of the present study have shown the acceptable result over other studies.

The moisture content of bombay duck (*H. nehereus*) sample was estimated 78.56±0.39% from three different measurements. The data are shown in table 5. Sultana et al. [26] found 85.47% moisture content of raw Bombay duck. In another study Roy et al. [27] found 85.86±1.20% of moisture content of *H. nehereus* just after 6 hours of collection. So the above studies indicate a close relationship with the present study on the basis of moisture content.

4.3 Protein Content

Estimated protein content found 11.76±0.3% and 13.74±0.04% for *M. rosenbergii* and *H. nehereus* respectively on this study (Table 5).

Begum et al. [28] found 18.51% protein from *M. rosenbergii* sample at the end of 10 days of iced storage condition. Chanmugam et al. [25] studied

proximate composition of *M. rosenbergii* and protein content found about 16.4%, which is higher than our present study. Sultana et al. [26] found 9.95% protein while studying Bombay duck along with other marine species. Haque et al. [23] found 8.75 ± 0.42% protein content while studying on raw Bombay duck. These studies show the data of present study exhibits slightly higher protein percentage.

4.4 Lipid Content

The result of lipid content is presented on Table 5. The percentage of lipid found 2.15±0.007% and 1.89±0.34% for prawn (*M. rosenbergii*) and Bombay duck (*H. nehereus*) respectively.

Begum et al. (2011) studied quality aspects of giant freshwater prawn (*Macrobrachium rosenbergii*) under different storage conditions and found 1.34% lipid content. Lipid content found 1.1 to 4.2% by analyzing 18 species of frozen shrimp and freshwater prawn exhibited higher lipid content over marine shrimp (3.18 vs. 1.33%) (Chanmugam et al. 1983).

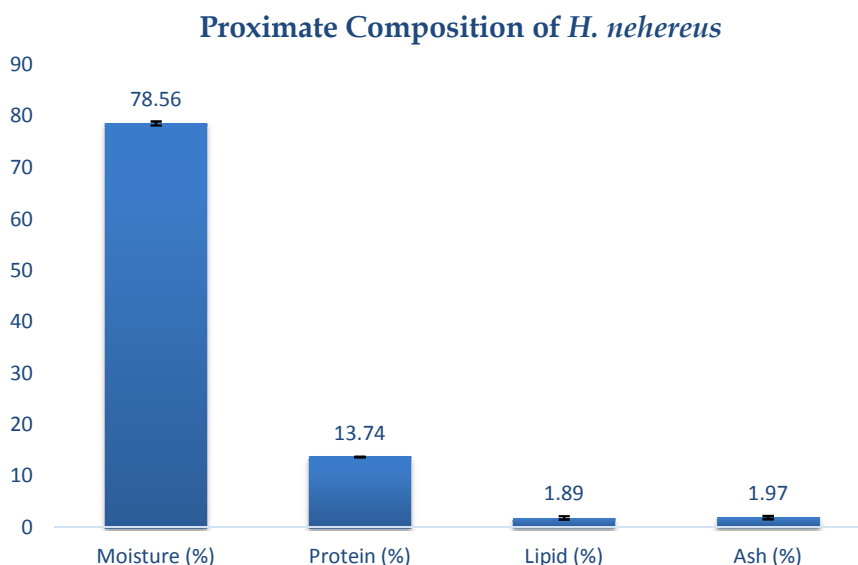


Fig. 3. Moisture, protein, lipid and ash percentage of *H. nehereus*

Table 5. TVB-N and TMA-N values of frozen storage *M. rosenbergii* and *H. nehereus* samples

Species	TVB-N (mg/100 g)	TMA-N (mg/100 g)
Prawn	19.3±0.45	3.19±0
Bombay Duck	22.37±0.15	2.09±0.04

*Values are mean ± SD of individual replications of sample

Sultana et al. (2008) studied quality assessment of rotating and solar tunnel dried marine fish product and found 1.95% lipid content in case of Bombay duck. Haque et al. (2013) studied quality of solar tunnel dried Bombay duck and Silver pomfret with traditional sun dried samples and found $1.88 \pm 0.33\%$ lipid content in case of Bombay duck (*H. nehereus*) sample. So, the above studies exhibit lipid percentage very closely to the present study.

4.5 Ash Content

The ash contents estimated on this study were presented in Table 5. Percentage was found $1.24 \pm 0.35\%$ and $1.97 \pm 0.31\%$ for *M. rosenbergii* and *H. nehereus* respectively.

Azam [4] studied the quality and safety aspects of fresh and frozen prawn (*M. rosenbergii*) and found ash content initially $2.13 \pm 0.09\%$ and $1.81 \pm 0.27\%$ after 4 weeks of frozen storage. On the other hand, Begum et al. (2011) [28] studied quality aspects of giant freshwater prawn (*Macrobrachium rosenbergii*) under different storage conditions and found ash content 0.97% initially during the study.

Haque et al. [23] studied quality of solar tunnel dried Bombay duck and Silver pomfret with traditional sun dried samples and found $0.71 \pm 0.01\%$ and $6.07 \pm 0.59\%$ ash content on raw and dry matter basis. Sultana et al. (2008) [26] found ash content of Bombay duck of about 1.8% and 12.39% on raw and dry matter basis respectively, while quality assessment of rotating and solar tunnel dried marine fish product. Estimated value of this experiment was quite similar to the result found by Sultana et al. [26].

4.6 TVB-N Values of *M. rosenbergii* and *H. nehereus*

Result of total volatile base nitrogen (TVB-N) content of both *M. rosenbergii* and *H. nehereus* fish sample were presented on Table 4. In case of prawn, TVB-N value was found 19.3 ± 0.45 mg/100g (Fig. 3). The low value of TVB-N initially is an indication of quality of fresh shrimp or fish while the high value may be due to action of autolytic enzymes and spoilage bacteria (Shewan and Ehenberg, 1957). Leitao and Rios (2000) reported that TVB-N content equal to 18.7 mg/100 g in fresh *M. rosenbergii* and 26 mg/100 g after 10 days of storage in ice. Acceptable limit of TVB-N for fish and shrimp is 30 mg/100 g muscle was reported by Connel [29]. The above

studies showed TVB-N value which was close to the value obtained by this study.

Total Volatile Base Nitrogen (TVB-N) content was found 22.37 ± 0.15 mg/100 g in this study for *Harpodon nehereus*. Reza et al. (2008) observed that the Total Volatile Base Nitrogen (TVB-N) content were 3.5 to 25.2, 1.9 to 8.9, 2.5 to 15.2, 3.6 to 15.6 & 5.3 to 19.0 mg/100 g for silver jew fish, bombay duck, big-eye tuna, Chinese pomfret and ribbon fish respectively. Islam (2001) [30] observed that Total Volatile Base Nitrogen (TVB-N) content of traditional dried ribbon fish, bombay duck, big-eye tuna, silver jew fish and Chinese pomfret ranged from 16.56-44.83 mg/100g. So the TVB-N content found in the present study for *H. nehereus* remained within acceptable limit.

4.7 TMA-N Values of *M. rosenbergii* and *H. nehereus*

The use of TMA-N, as an index of fish freshness, was proposed by Gibbon and Labire (1937). This was based on the observation that the production of TMA was dependent on the bacterial activity as well as from endogenous enzyme.

Tri-methyle amine nitrogen (TMA-N) content of *M. rosenbergii* and *H. nehereus* were found 3.19 ± 0 and 2.09 ± 0.04 mg/100 g for *M. rosenbergii* and *H. nehereus* respectively (Table 5).

Gibbon and Labire [31] suggested a TMA-N content of 4-6mg/100g as the critical value for the edibility of fish, while Connell recommended 10-15mg/100g for human consumption. The TMA-N content found in this study for *M. rosenbergii* was slightly lower than the critical value showed by Gibbon and Labire [31], which indicated the acceptability of this species for human consumption.

In case of *H. nehereus*, TMA-N content found 2.09 ± 0.04 mg/100g. Castell and Triggs [24] suggested wide variation in critical values of TMA-N ranges from 1-5 mg/100g for marine fish (haddock). So the value obtained in this study was within the acceptable limit.

5. CONCLUSION

To know the proximate analysis of various fish species from different sources is important for preparing a commodity satisfying the quality requirements and safety aspects. Organoleptic

quality evaluation of *M. rosenbergii* and *H. nehereus* resulted with defect point 1.57 and 1.40 respectively, which indicates the excellent quality of both the samples. Both the sample species exhibit bright coloration, firm and elastic texture, characterizing by fresh odor. In considering human health issues, these species exhibit high nutritional value with low level of hazardous contents. These species exhibits perfect quality for further processing operations in the industry. So, it can be said that, this study will be helpful for the nutritionists and food processors to ensure the quality and safety aspects of *Macrobrachium rosenbergii* and *Harodon nehereus*.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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