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Analysis of Physicochemical Water Quality Parameters in Some Selected Haor Areas of Kishoregonj District

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Abstract

The study was conducted to investigate the physicochemical parameters and anionic constituents in water of the haor area of Karimganj during the period from October to December 2016. The water samples were collected from 3 different sampling stations as St-1 (Baila beel), St-2 (Umma beel) and St-3 (Alkhara beel) for analyzing the temperature, electrical conductivity (EC), total dissolved solid (TDS), pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), alkalinity, hardness,fluoride (F), chloride (Cl^-), bromide (Br^-), nitrite (NO_2^-) , nitrate (NO_3^-), and sulphate (SO_4^{2-}) in water. The study also assessed the fish diversity status of the Karimganj haor area. The result of the study showed that the mean temperature (26.2°C) of water was within the standard limit. The mean EC and TDS contents were 555 µS/cm and 526 mg/l, respectively which was satisfactory level for aquatic organisms. The mean DO (6.7 mg/l) content was favorable but BOD (2.7 mg/l) content indicated some extent of organic waste pollution.The mean pH and alkalinity were 7.30 and 338 mg/l, respectively indicated alkaline condition in haor water, and whereas hardness was 122 mg/l revealed that the water was suitable for fish production. The mean concentration of F^-, Cl^- , Br^-, NO_2^- , NO_3^-, and SO_4^{2-} were 0.35, 130.3, 0.16, 3.38, 34.84 and 85.60 mg/l, respectively depicted that the water were poorly improvised with these anionic constituents.

***Keywords:** Physicochemical parameters; Anionic constituents; Dissolved oxygen; Nitrate; Pollution*

Introduction

An aquatic ecosystem is the way in which living organisms interact within a body where groups of interacting organism dependent on one another and their water environment for nutrients and shelter. Bangladesh possesses enormous area of aquatic ecosystems in rivers and streams, freshwater lakes and marshes, haors, baors, beels, water storage reservoirs, fish ponds, flooded cultivated fields and estuarine systems with extensive mangrove swamps [1]. Fish supplements about 60% of our daily animal protein intake. More than 17 million people including about 1.4 million women depend on fisheries sector for their livelihoods by fishing, farming, fish handling and processing [2]. It is also essential for regulation of natural processes and the earth's life support systems e.g. carbon sequestration, methane gas emission, soil formation, and

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purification of water and essential for pollination of commercially valuable crops and biological control of pests and diseases, so aquatic environment has great importance for ecological and economic aspects.

Pollution in aquatic environment is a growing problem worldwide and currently it has reached an alarming rate [3]. In Bangladesh, most of lands in terms of geographical elevation are lower than 8 meter and most of lands in terms of geographical elevation are lower than 8 meter. As a result Bangladesh is a country of river and it is rich in wetland resources. There are about 114160 hectares of beels, 192367 hectares of haors, and about 5488 hectares of baors in Bangladesh [1]. Haor areas comprise the seven north-eastern districts (Sylhet, Sunamgonj, Moulovibazar, Hobigonj, Brahmanbaria, Kishorgonj and Netrokona) of Bangladesh. There are altogether 41 haors comprising an area of about 8000 km dispersed in the districts of Sunamganj, Sylhe, Moulvibazar, Hobiganj, Netrakona, Kishoreganj and Brahmanbaria where about 20 millions people live in 24 thousands square kilometers. Especially on haors are large bowl-shaped floodplain depressions located mostly in the north-eastern part of Bangladesh e.g. Kishoreganj district. Haor is a mosaic of aquatic habitats including rivers, streams and irrigation canals, large area of seasonally flooded cultivated plains and combination of hundreds of inter-connect beels.

Haors are used for agriculture during dry season and fisheries during rainy season have profound not only ecological importance but also environmental importance. Over the years, the population of natural fish species has declined considerably due to increased fishing pressure, and various anthropogenic activities leading to siltation, aquatic pollution, and loss of natural habitat for spawning and growth. There are a number of threats to haor area, some of the most common threats are:pollution like pesticides, fertilizers/nutrients, metals, oil spills, solid waste and sewage disposal; Climate change effects such as rise of temperature, drought, floods, cyclones, storms, sea-level rise;other problems are rivers regulation and water diversion irrigation infrastructure including floods control dams/dykes; overexploitation of resources (fish, turtles, tortoise, water fowls, reeds, trees, aquatic plants); conversion and drainage of wetlands for agriculture, aquaculture, and commercial development;human settlement/habitation deforestation or destruction of forests; extraction of minerals and peat; introduced pest plants and animals (invasive plants and animals); algal blooms/eutrophication trans-boundary water regulations and pollution; dewatering of water bodies for fishing; and siltation due to removal of vegetation .

During the last few decades, agricultural activities have been expanded in the wetland area of Kishoreganj district very rapidly which has affected the wetland ecosystems adversely both in qualitative and quantitative aspects [4]. Siltation, over-exploitation of natural resources, improper use of agrochemicals and other natural and man-made interruptions are the causes for depletion of haor area , which result scarcity of food, fuel, fodder, degradation of habitat and poverty, therefore, the risks of pollution impact are rising upwards sequentially [5]. According to Sabbir et al. [6], water quality focuses on the various aspects of the physicochemical parameters and anionic constituents of water that detect the status of pollution and suitability of a particular water body for various aquatic organisms as well as fisheries. The water quality of a water body largely depends on the interactions of various physicochemical factors [6], on the other hand, nutrient properties in aquatic ecosystems are usually monitored by measuring their anionic concentrations in water [7]. Thus, the investigation of physicochemical parameters and anionic concentrationsin water of the Kishoreganj haor area is essential since even slight changes in their concentration above the acceptable levels can result in serious environmental and subsequent impact on fisheries management. So, the study was carried out to investigate the physicochemical water quality parameters in Karimganj haor area of Kishoreganj district and to analyze the major anions in the Karimganj haor area of Kishoreganj district.

Materials and Methods

Study area

The study area was located in the Karimganjhaor area, Kishoreganj district which was approximately latitude 24°45'83"N and longitude 90°88'33"E. The area is a massive water world around the study area and only water all around, and few islands like villages amid of the water. The Kishoreganj District with an area of 2688.59 km^2 is bounded by Netrokona and Mymensingh districts on the north, Narsingdi district on the southwest and Brahmanbaria district on the southeast, Sunamganj and Habiganj districts on the east, Gazipur and Mymensingh districts on the west [8].

Samples collection

The water samples were collected from 3 sampling stations denoted as St-1 (Bailabeel), St-2 (Ummabeel) and St-3 (Alkharabeel) of the haor area during the period from October 2016 to December 2016. To analyze the water quality, 500 ml water was collected by plastic bottles with double stoppers from each sampling points. Before sampling, the bottle were cleaned and washed with detergent solution and treated with 5% nitric acid (HNO_3) over night. The bottles were finally rinsed with deionized water and died. At each sampling station, the sampling bottles were rinsed at least three times before sampling was done. Pre-prepared sampling bottles were immersed about 10 cm below the surface water. After sampling, the bottles were screwed carefully and marked with the respective identification number. The samples were acidified with 10% nitric acid (HNO_3), were placed in an ice bath and were brought to the laboratory. The samples were filtered through 0.45 µm micro-pore membrane filter and were kept at freeze to avoid further contamination until analysis.

Sample analysis

The physicochemical parameters of water samples were analyzed in the laboratory of the Department of Environmental Science and Resource Management, Mawlana Bhashani Science and Technology University, Tangail and Department of Biochemistry and Molecular Biology, Bangladesh Agricultural University, Mymensingh. The water temperature and pH were determined by the thermometer and digital pH meter (Model: pH Scan WP 1, 2 and made in Malaysia), respectively. Digital EC and TDS meter (Model: HM digital and made in Germany) was used to determine EC and TDS, respectively. The DO was determined by digital DO meter (Model: D.46974 and made in Taiwan). The BOD was measured by two steps where initial DO_1 was measured immediately after collection and after 5 days DO_5 was measured by incubation in the dark condition at 20℃ for 5 days. Alkalinity was determined by titration method with 0.1 N HCl after addition 2-3 drops of methyl-orange indicator and hardness was also determined by titration method. For analysis of anionic properties in water the prepared sample was taken in a vial and analyzed for F^-, Cl^-, Br^-, NO_2^- , NO_3^-, and SO_4^{2-} by Ion Chromatograph (HIC-10-A, Shimadzu, Japan) in the laboratory of the Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh

Statistical analysis: The collected data were compiled and tabulated in proper form and were subjected to statistical analysis. The Microsoft Office Excel software was used to present and interpret the collected data. The results of the study were presented in charts and tabular forms.

Results and Discussion

Physicochemical water quality parameters

The highest temperature of the haor was 27.6℃ at St-3 in October and the lowest was 24.4℃ at St-2 in November, whereas the mean temperature of the study was 26.2℃. The standard limit of water temperature is 20.0 to 30.0℃ [9] and the study showed that all the recorded temperature was within the standard limit. In the Ashuliabeel, the water temperature was found 28.7 to 31.7℃ during wet season and 22.4 to 25.6℃ during dry season, respectively, which was found within the standard by EQS (1997) ranged indicated that almost suitable for fishes or aquatic habitat and breeding ground as well [10] and this study

is almost similar to the present study.

The highest EC of the haor was found 630 µS/cm at St-2 in December and the lowest was 484 µS/cm at St-1 in October with the mean EC was 555 µS/cm and the standard limit of EC in water is 700 µS/cm [9] and the study showed that all the observed EC were within the standard limit. In wet season the ranges of EC was ranged from 130 to 310 µs/cm and in dry season the ranges of EC was 341 to 442 in the Ashuliabeel, might be due to the seasonal variations [10] comparatively lower than the present study. EC ranged from 645 to 688 µS/cm during the dry season and the mean EC was 663 µS/cm in the Mokeshbeel showed that all the observed values were within the standard limit [11] and all these studies are relatively similar to the present study.

The highest TDS content of the haor was recorded 568 mg/l at St-2 in December and the lowest was 468 mg/l at St-3 in October (**TABLE 1**). The mean TDS content of the study was 526 mg/l and the standard limit of TDS in water is 1000 mg/l [12] and the study showed that all the observed TDS contents were within the standard limit. In Ashuliabeel, TDS ranged from 80 to 132 mg/l in wet season and 207 to 276 mg/l in dry season [10]. The highest TDS content of the Mokeshbeel was observed 586 mg/l in February and the lowest was 541 mg/l in March which were within the standard limit [11] and these studies are found almost similar to the present study.

The highest DO content of the haor was found 6.8 mg/l at St-1 in October and December; and the lowest was 6.4 mg/l at St-2 in November, along with the mean DO content 6.7 mg/l. The standard limit of DO is 5.0 mg/l [9] and the study showed that most of the recorded DO contents were higher than the standard value depicted that the beel water quality was satisfactory level and it was suitable for fisheries and aquatic organisms. The DO contents of Chatlabeel was ranged from 6.6 to 7.0 mg/l [13], while the highest DO content of the Mokeshbeel was observed 5.5 mg/l and the lowest was 4.1 mg/l [11] showed the satisfactory level of DO contents, which were almost similar to the present study. The range of investigated DO was 1.1 to 2.1 mg/l during the wet and 0.5 to 2.0 mg/l during the dry season in the Ashuliabeel [10] revealed that the DO content was much lower than the desired limit of 5.0 [9], reported that the beel water quality was degraded and it was not suitable for fisheries and aquatic organisms, which was opposite to the present study, might be due to the presence of higher level of organic waste pollutant.

The highest BOD content of the haor was found 2.8 mg/l at St-1 in October and December; and the lowest was 2.4 mg/l at St-2 in November, along with the mean BOD content of the study was 2.7 mg/l. The standard limit of BOD is below 2.0 mg/l [9] and the study showed that most of the recorded BOD contents were slightly higher than the standard depicted that the beel water quality was not satisfactory level and it was not suitable for fisheries and aquatic organisms. BOD contents were found to ranges from -4.42 to 1.6 mg/l in wet and 1.0 to 3.0 mg/l in dry season in the Ashuliabeel revealed that the BOD concentrations within the desirable limit for fisheries activities [10]. The BOD contents of Chatlabeel was ranged from 3.6 to 7.2 mg/l [13] revealed that negative condition of the water body. Due to dumping of various waste into the water, the Pungli river water exceeded the standard limit of BOD content during post-monsoon season [14], which is almost similar to the present study.

The highest pH of the haor was recorded 7.45 at St-3 in December and the lowest was 7.15 at St-1 in February, with the mean pH level of the study area was 7.30. The standard limit of pH is 6.5 to 8.5 [15] and the study showed that almost all of the recorded values were within the standard limit. The ranges of pH were investigated 7.1 to 7.8 during wet and 7.1 to 8.4 during dry season that confirmed the slightly alkaline nature of water of the beel [10], while the pH of Chatlabeel water was ranged from 6.5 to 6.9 [13]. The pH both in wet and dry season of Ashuliabeel was suitable for fisheries where Chatlabeel water was slightly acidic. The highest pH of the Mokeshbeel was 7.55 and the lowest was 7.25 revealed that water tends be

alkaline, this may be due to the alkali contain waste and effluent into the water and heavy rainfall [11] and these studies are almost similar to the present study.

TABLE 1. **Physicochemical water quality parameters of the haor area.**

Parameters	Sampling stations	Months			Mean	Standard
		October	November	December		
Temp. (°C)	St-1	27.5	26.8	24.5	26.2	20.0-30.0 (EQS, 1997)
	St-2	27.3	26.7	24.4	26.1	
	St-3	27.6	26.9	24.6	26.4	
EC (µS/cm)	St-1	484	553	625	554	700 (EQS,1997)
	St-2	487	557	630	558	
	St-3	488	556	615	553	
TDS (mg/l)	St-1	476	540	560	525	1000 (ADB,1994)
	St-2	470	545	568	527	
	St-3	468	542	566	255	
DO (mg/l)	St-1	6.8	6.7	6.8	6.8	5.0 (EQS,1997)
	St-2	6.7	6.4	6.5	6.5	
	St-3	6.8	6.6	6.7	6.7	
BOD (mg/l)	St-1	2.8	2.7	2.8	2.8	below 2.0 (EQS,1997)
	St-2	2.5	2.4	2.5	2.5	
	St-3	2.7	2.6	2.7	2.7	
pH	St-1	7.15	7.23	4.45	7.28	6.5-8.5 (ECR,1997)
	St-2	7.23	7.34	7.4	7.32	
	St-3	7.18	7.35	7.42	7.32	
Alkalinity (mg/l)	St-1	315	335	366	338	>100(Rahman.,1992)
	St-2	325	338	356	340	
	St-3	322	342	348	337	
Hardness(mg/l)	St-1	112	125	127	121	123 (Huq and Alam, 2005)
	St-2	115	128	126	123	
	St-3	122	124	125	122	

The highest alkalinity of the haor was recorded 366 mg/l at St-3 in December and the lowest was 315 at St-1 in February, with the mean alkalinity level of the study was 338 mg/l. The standard limit of alkalinity is >100 mg/l [16] and the study showed that almost all of the recorded values were better for aquatic organisms. The ranges of alkalinity were 30 to 63 mg/l during wet and 90 to 115 mg/l during dry season that confirmed the acidic nature of water of the beel [10], while the alkalinity of Chatlabeel water was ranged from 25 to 35 mg/l [13]. The alkalinity both in wet and dry season of Ashuliabeel and Chatlabeel water was slightly acidic.

The highest hardness of the haor was recorded 128 mg/l at St-2 in November and the lowest was 112 at St-1 in October, with

the mean hardness level of the study was 122 mg/l. The standard limit of hardness is 123 mg/l [17] and the study showed that almost all of the recorded values were better for aquatic organisms. The ranges of hardness were investigated 30 to 91 mg/l during wet and 115 to 127 mg/l during dry season [10], while the hardness of Chatlabeel water was ranged from 60 to 180 mg/l [13]. The hardness both in wet and dry season of Ashuliabeel and Chatlabeel water was good for aquatic environment.

Anionic properties in water

The study showed that the highest concentration of fluoride of the haor was 0.47 mg/l at sampling St-2 in December and the lowest was 0.21 mg/l at St-1 in October. The standard of fluoride is 1.70 mg/l [18] and all the recorded values were lower than the standard levels. The result revealed that the water of the haor was not impoverished with F- containing substances. Quraishi et al. [19] studied that, the concentration of F- ranged from 0.20 to 0.30 mg/l in Gulshanlake, Bangladesh, which is almost similar to the present study (**TABLE 2**).

TABLE 2. **Anionic water properties (mg/l) of the haor area.**

Anions	Sampling stations	Months			Mean	Standard
		October	November	December		
Fluoride (F^-)	St-1	0.21	0.35	0.43	0.33	1.7 (EU, 1989)
	St-2	0.24	0.39	0.47	0.37	
	St-3	0.28	0.34	0.46	0.36	
Chloride (Cl^-)	St-1	110.2	125.6	145.7	124.5	250 (EU, 1989)
	St-2	120.5	128.8	154.6	134.5	
	St-3	114.5	130.4	148.2	132	
Bromide (Br^-)	St-1	0.12	0.17	0.14	0.14	10 (EU, 1989)
	St-2	0.15	0.14	0.17	0.15	
	St-3	0.18	0.19	0.16	0.18	
Nitrite ($NO2^-$)	St-1	1.42	3.11	4.32	2.95	0.5 (EU, 1989)
	St-2	3.72	3.67	4.87	4.08	
	St-3	1.88	2.65	4.85	3.12	
Nitrate (NO_3^-)	St-1	24.21	34.98	39.64	32.94	50 (EU, 1989)
	St-2	32.45	38.97	42.84	38.09	
	St-3	27.45	32.76	40.65	33.62	
Sulphate (SO_4^{2-})	St-1	90.38	93.22	99.64	94.41	200 (EU, 1989)
	St-2	65.8	71.42	82.52	73.25	
	St-3	88.32	88.52	90.65	89.16	

The highest chloride concentration of the haor was 154.6 mg/l at station St-2 in December and the lowest was 110.2 mg/l at St-1 in October. The standard of chloride is 250.0 mg/l [18] and all the recorded values were lower than the standard levels. The result revealed that the water of the haor was not impoverished with Cl^- containing substances. Ahmed et al. [20] found that, Cl^- contentin Buriganga river water during rainy, dry and summer seasons were 60.74, 69.18 and 59.4 mg/l, respectively and in Karnatoli river water Cl- content was 17.18, 33.53 and 22.3 mg/l during rainy, dry and summer season, respectively.

This result differs from the present study due to seasonal variation and excessive amount of rainfall.

The study found that the highest concentration of bromide of the haor was 0.19 mg/l at St-3 in November and the lowest was 0.12 mg/l at St-1 in October. The standard of bromide is 10.00 mg/l [18] and all the recorded values were much lower than the standard levels. The result revealed that the water of the haor was not impoverished with Br^- containing substances as well as not satisfactory level for fish production. The highest concentration (0.25 mg/l) of bromide was observed in dry season as months of February and March [21], which is relatively similar to the present study.

The highest nitrite concentration of the haor was 4.87 mg/l at St-3 in December and the lowest was 1.42 mg/l at St-1 in October. The standard of nitriteis 0.50 mg/l [18] and all the recorded nitrite concentrations were much higher than the standard levels. The result revealed that the water of the haor was highly impoverished with NO_2^- containing substances. It might be due to the direct discharge of NO_2^- containing substances into the haor water. Nitrites are the intermediate products which occur in water distribution systems and natural waters. Alam et al. [22] found that the concentration of nitrite at Demra in Shitalakhya River was 0.2 mg/l in rainy season and 0.3 mg/l in dry season, which was almost opposite to the present study.

The study recorded that the highest concentration of nitrate of the haor was 42.84 mg/l at St-2 in December and the lowest was 24.21 mg/l at St-1 in October. The standard of nitrate is 50.00 mg/l [18] and all the recorded values were lower than the standard levels. The result revealed that the water of the haor was not impoverished with NO_3^- containing substances as well as not satisfactory level for fish production. The concentration of NO_3^- was ranged from 1.2 to 3.2 mg/l in rainy season and from 11 to 13.5 mg/l in dry season at Demra in Shitalakhya River [22].

The highest sulphate concentration of the haor was 99.64 mg/l at St-3 in December and the lowest was 71.42 mg/l at St-2 in November. The standard of sulphate is 200.00 mg/l [18] and all the recorded nitrite concentrations were much lower than the standard levels. The result revealed that the water of the haor was not impoverished with sulphate containing substances. Alamet al. [22] recorded that the SO_4^{2-}concentration was ranged from 130 to 151 mg/l in rainy season and from 13.5 to 15.3 mg/l in dry season at Demra in Shitalakhya River.

Conclusion

From the overall discussions, it can be concluded that the physicochemical parameters and anionic properties of haor water mostly within the standard level that was suitable for aquatic environment as well as for fish production. But there were several human made problem exist that may affect the water quality in future. For these reasons the study recommended to conserve the quality of the haor water and its environment by regular monitoring of haor water quality with the standards of DoE, keep records about fish species and their status, illegal dredging must be stopped, building awareness among the local people to conserve the haor with local participation.

RESULTS

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