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Determination of water quality parameters in Jamuna river

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Abstract

The principle goal of the current investigation is to determine different water quality parameters of Jamuna river, which is flowing through Tangail district of Bangladesh as one of the most influencial rivers. To collect the water samples, three sampling sites were selected (Gobindashi, Kuthiboira, Bheruа) and the research was conducted throughout the year of 2019 maintaining two months of intervals. These areas were selected due to the usage of water for drinking, domestic purposes, irrigation, dredging and immense sailing of motorized boats. Water samples were collected from 8 am to 12 pm and analyzed for water quality parameters such as temperature, transparency, pH, dissolved oxygen, total alkalinity, ammonia-nitrogen, phosphate-phosphorus, chlorophyll-*a*. The mean values of these parameters were compared with the standards set by FAO and WHO for analyzing the suitability of river water for drinking and aquaculture purposes. The sample analysis revealed that the river water was turbid and slightly alkaline. Also, pH, dissolved oxygen and ammonia were in suitable range throughout the inquiry. From correlation matrix, it was also observed that chlorophyll-*a* had a relationship with pH and ammonia-nitrogen. However, from this year-round survey, it can be concluded that further research is necessary for better and sustainable fish production. For accurate exploitation of aquatic resources such investigations of water quality is indispensable.

Keywords: Jamuna river, physico-chemical parameters, year-round survey

Introduction

Water is an exigent asset for the existence of life on this planet. Water is absolutely necessary both for the survival of human beings and other living animals. The oceans, streams, ditches, lakes, estuaries along with other reservoirs forms nearly 70% surface of the earth. Water quality is a term which is used to describe the physical, chemical and biological properties of a particular waterbody. The water quality assessment provides a clear information about the subsurface geologic environments in which the waterbodies are present [1]. Since the water quality is the most urgent limiting factor, proper growth and survival of an aquatic animal is improbable without quality water. Though water is a vital requirement for our everyday life, quality of water is being deteriorated by various anthropogenic (industrial wastes, agricultural runoff) and natural events (weathering of soil, volcanic eruptions). The increased growth of industries and massive usage of pesticides in agricultural fields are the main sources of the pollution in waterbodies. These types of agricultural pollutants have severe impact on water pollution, as most of the pollutants are resistant to natural degradation [2]. Therefore, it is major concern of fact that good water quality will be a scarce resource in near future.

The Jamuna river is one of the most significant rivers of Bangladesh, which is the subordinate watercourse of the Brahmaputra river. It originates from Tibet, then crossing into India enters into Bangladesh from the southwest. But during past few decades, the water quality of Jamuna river is being affected by domestic purposes as well as the application of fertilizers and pesticides. For the maintenance of water, it is essential to keep a record of different parameters whether they are suitable for drinking and aquaculture purposes. The prime objectives of this study is to assess different water quality parameters such as temperature, transparency, pH, DO, total alkalinity, chlorophyll-*a*, ammonia-nitrogen, phosphate-phosphorus etc. and compare them with the water quality standards set by FAO and WHO for suitability. This will facilitate a balanced and comprehensive management of water quality for accurate usage and sustainability of important and vulnerable water resources.

Study Area
The study was conducted at Bhuapur Upazila in Tangail district of Bangladesh. The area was divided into three stations known as Gobindashi, Kuthiboira and Bherua which were almost 3 km away from each other. Locations of these three stations are showed in Figure 2


Fig 1: Jamuna River and **Fig 2:** Map of study area (Bhuapur upazila, Tangail district)

Materials and Methods
Sampling procedure
500 ml plastic bottles were used which were covered by black color tape previously. Before collecting the samples, each of them were washed properly by distilled water. Then bottles were again rinsed with sample water. Water samples were collected between 8 am to 12 pm. Water samples were collected by using a semi-circular tube sampler (3-4 feet). The tube was used in a way that water from all the layers can be collected. Each bottle was marked with sampling site and sampling number and then transported to the laboratory with great care for analysis.

Physical factors
Temperature
Procedure
Water temperature was measured by using a Celsius thermometer at the sampling site.

Transparency
Procedure
Transparency of the river water was also determined at the sampling site using a secchi disc of 20 cm diameter. At first, the secchi disc was pierced into the water to the view of naked eye and then the length that was under the water was recorded in cm by a measuring tape at the river.

Chemical factors
pH
Procedure
At first, pH was standardized with distilled water. Then 50 ml sample water was taken into a glass beaker and pH meter was dipped into the sample and waited for the required time. With the help of a direct reading digital pH meter (HEQEP CP 60M G2) pH of the river water was determined.

Dissolved oxygen
Procedure
DO was also determined by digital DO meter (HEQEP CP 60M G2). Firstly, water was standardized with distilled water. After that, 50 ml sample was taken into a glass beaker and DO meter dipped into the water. Then the reading was recorded.

Total Alkalinity
Procedure
50 ml sample water was taken into a conical flask and three drops of methyl orange added as an indicator. Then, titration was done with 0.02N H_2SO_4 until the final color appeared. Finally, total alkalinity was determined by using the following formula:

Total alkalinity= (Final reading-Initial reading) $\times$ 20

Chlorophyll-*a*
Procedure
Chlorophyll-*a* was measured by (Whatman GF/F) filter paper. After filtering, the filter papers were dissolved on 10 ml acetone and kept overnight in refrigerator (4^0C). Then centrifuged (PMHCL-100/09) for 30 minutes at 1000 rpm and made ready for the analysis. Wavelength at 664 nm and 750 nm by using a direct reading spectrophotometer (T80 UV/VIS spectrometer) was recorded and used to determine chlorophyll-*a* by following equation:
Chlorophyll-*a* in µg/L = $(11.9 \times (A_{664}\text{-}A_{750}) \times V \times 1000/L \times S)$

Ammonia-nitrogen
Procedure
25 ml sample was taken in a beaker and 25 ml deionized water was also taken in another beaker. After that, three drops of mineral stabilizer, three drops polyvinyl alcohol and 1 ml Nesler reagent was added to each beaker and kept 1 minute for reaction. From each solution, 10 ml was taken into sample cell and the concentration of ammonia-nitrogen was determined by using digital T80 UV/VIS Spectrophotopmeter.

Phosphate-phosphorus
Procedure
At first, 10 ml sample water was taken into a conical flask and one phosver-3 powder pillow was added and allowed 2 minutes for reaction. Also, 10 ml mother sample was taken into another cell and determined the concentration by using digital spectrophotometer (T80 UV/VIS spectrometer).

Data Processing and Analysis
The relevant data were processed and analyzed through SPSS and one way analysis of variance (ANOVA).

Results and Discussion
Temperature
Temperature is one of the most important factors in aquatic system as biological activities and growth of aquatic animals is dependent on it. The temperature of three areas ranged from 21-31^{0}C. The fluctuation of river water temperature usually depends on the season, geographic location, sampling time and temperature of effluents entering the stream [4]. In case of river water temperature, the DoE standard for sustaining aquatic life is within 20 to 30^{o}C in both dry and wet season [5]. All samples of the river water were within the range of DoE standard except the month of August (Area 1) which was 31^{0}C.

Table 1: Statistical analysis of water quality parameters of the Jamuna river

	(Gobindashi) Area 1	(Kuthiboira) Area 2	(Bherua) Area 3	WHO Standards [6]	FAO Standards [7]
Temperature (^{0}C)	26.33±1.56	25.67±1.67	26.17±1.62	-	-
Transparency (cm)	24.33±2.62	20.67±2.49	20.83±2.75	-	-
pH	8.26±0.34	8.27±0.38	8.35±0.34	6.5-8.5	6.0-8.5
DO (mg/L)	7.74±0.31	7.54±0.40	7.95±0.35	5-7	>4
Total alkalinity (mg/L)	86.5±8.62	83.5±8.62	79.67±7.92	120	-
Chlorophyll-*a* (µg/L)	0.26±0.09	0.21±0.09	0.19±0.04	-	
Ammonia-nitrogen (mg/L)	0.18±0.10	0.21±0.10	0.20±0.11	-	5
Phosphate-phosphorus (mg/L)	0.32±0.07	0.44±0.12	0.18±0.06	0.1	2

Transparency

Transparency is an evident of clarity of any waterbody. The transparency of the river water was generally low. Lower transparency usually occurs by suspended solid particles (clay, silt, sand), microscopic animals and plants as well as higher availability of pathogens. The highest transparency was found 32 cm (Area 1) in the month of April while the lowest was 11 cm (Area 3) in the month of August. The transparency of productive freshwater ranged from 35-45 cm [8] and below this level indicates the poor condition of waterbody.

pH

pH is a relative indicator of water that is changing chemically [9]. Very high pH (pH>9.5) or very low pH (pH<4.5) values are unsuitable for most aquatic organisms. Aquatic organisms are extremely sensitive to pH levels below 5 and may die at these low pH values. High pH levels (9-14) can harm fish due to the fact that ammonia will turn to toxic ammonia at high pH (>9) [10]. However, highest concentration of pH 9.74 was found in December (Area 2) and lowest concentration of pH 7.05 was found in March (Area 1). pH levels that were measured, are more or less suitable for aquaculture according to FAO.

DO

Several gasses were found in dissolved condition in natural waterbodies such as oxygen, nitrogen, carbon dioxide etc. But among them, dissolved oxygen is the most critical one. In fact, a constant supply of DO is necessary for all aquatic organisms except anaerobic bacteria. In a healthy water body that ensures good water quality, DO must be > 4mg/l [11]. DO concentration of the river water was suitable according to WHO and FAO.

Total alkalinity

Total alkalinity (TA) constitutes an important factor in determining the buffering capacity of a waterbody [12]. Alkalinity does not directly help aquatic biota production. Nutrients are found in higher quantities in alkaline water, which helps the productivity of water. Throughout the research, the maximum TA was found 121 mg/L (Area 1) in October and minimum was 53 (Area 3) in June, which is favorable for aquaculture.

Chlorophyll-*a*

It is used to indicate the tropical condition of a waterbody. Higher levels of nutrients from fertilization, sewage and urban runoff results in higher concentration of chlorophyll-*a* and excess algal growth. The utmost concentration of chlorophyll-*a* was 0.57 µg/L (Area 1) in December and minimal concentration was 0.01 µg/L (Area 1) in February.

Ammonia-nitrogen

Ammonia-nitrogen is a measure for the amount of ammonia, a toxic pollutant often found in landfill leachate [13]. However, Bangladesh standard of ammonia for drinking surface water is 0.5 mg/l. Throughout the study period, ammonia concentrations of the river water was within range (Table 1), which means that it is safe to use river water for drinking and domestic purposes.

Phosphate-phosphorus

It is an essential nutrient as well as an indicator of anthropogenic biological pollutions [14]. Higher levels of phosphate concentrations are responsible for eutrophication of an aquatic ecosystem. During this study, maximim concentration 0.92 mg/L was found in October (Area 2) and lowest 0.09 mg/L was found in June (Area 3). However, the level of phosphates was suitable for aquaculture according to FAO.

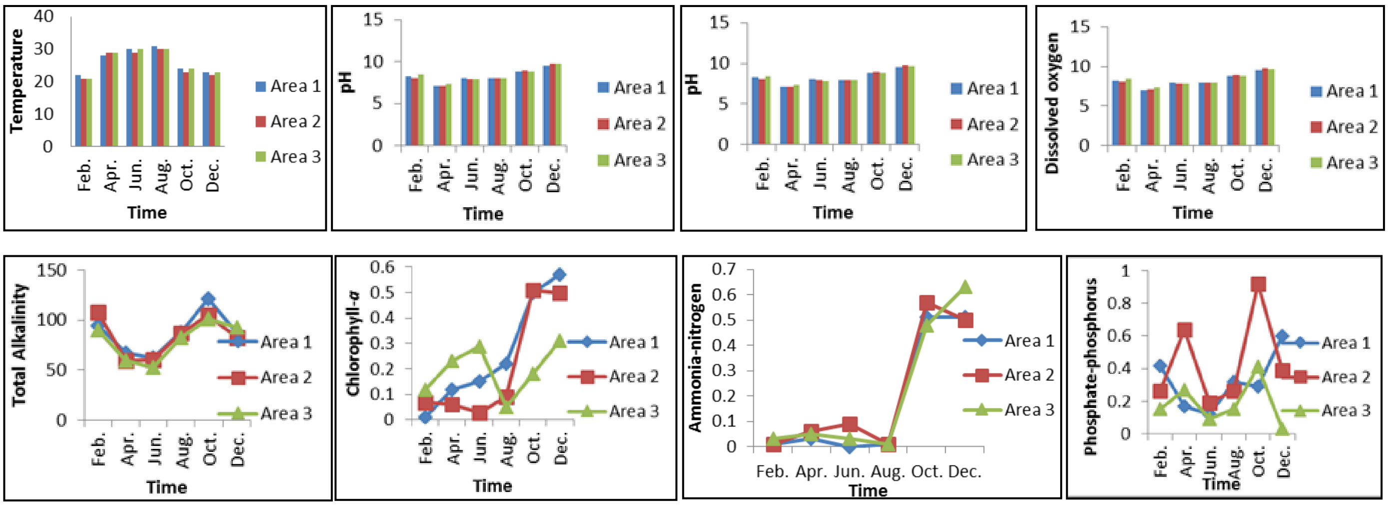

Table 2: Correlation matrix of different water quality parameters

	Tem.	Tran.	pH	DO	T.A.	Chl.-*a*	NH_3	PO_4
Tem.	1	-0.276	-0.666**	-0.803**	-0.671**	-0.353	-0.549	-0.277
Tran.	-0.276	1	-0.034	0.119	-0.280	0.107	-0.028	-0.169
pH	-0.666**	-0.034	1	0.698**	0.568*	0.697**	0.845**	0.186
DO	-0.803**	0.119	0.698**	1	0.599**	0.266	0.336	-0.079
T.A.	-0.671**	-0.280	0.568*	0.599**	1	0.328	0.511*	0.272
Chl.-*a*	-0.353	0.107	0.697**	0.266	0.328	1	0.795**	0.399
NH_4^+-N	-0.549*	-0.028	0.845**	0.366	0.511*	0.795**	1	0.391
PO_4^{3-}—P	-0.277	-0.169	0.186	-0.079	0.272	0.399	0.391	1

** Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

From Table-2, it is clear that temperature showed a significantly negative relationship with pH (-0.666), DO (-0.806) and total alkalinity (-0.671). Conversely, pH showed a significantly positive relationship with DO (0.698), chlorophyll-*a* (0.697) and ammonia-nitrogen (0.845). Similarly, DO indicates a significantly positive relationship with pH (0.698) and total alkalinity (0.599) and chlorophyll-*a* showed a significantly positive relationship with ammonia-nitrogen (0.795).

Conclusion

To conclude, though temperature, pH, DO, total alkalinity, ammonia-nitrogen were in acceptable range according to FAO and WHO standards, transparency was poor which may be due to massive growth of plankton or microscopic pathogens. Whether it is plankton or pathogens that results in poor condition of transparency need to be clarified by further research. It was also noticed that adjacent lands were using extensively for growing crops. It should be controlled so that agricultural effluent cannot enter into the river water which can cause harmful effects on water quality. Additionally, regular monitoring of water quality and sustainable proper management is necessary for the sustainability.

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