

WATER QUALITY PARAMETERS OF SIX SELECTED OXBOW LAKES (BAORS) IN BANGLADESH

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In Bangladesh, naturally formed oxbow lakes, locally known as *Baors* are situated in the south-western part of the country. The increasing demand for water and the wide variety of water uses have impaired many water bodies including the *Baors*⁽¹⁾. Lakes in Bangladesh face many threats and this is in part due to the dearth of knowledge on the status of lakes as well as the lack of awareness, resource management and appropriate monitoring⁽¹⁾. Physico-chemical parameters are one of the important water quality monitoring tools as any change of these parameters may affect the survival of living organisms^(1,2). This study was conducted to observe some physico-chemical parameters in six selected natural oxbow lakes - *Baors* for proper management of the *Baors*.

The investigation was carried out during June, 2009 - March, 2010 in 6 oxbow lakes, named as the Bergobindopur *Baor* (upazila: Chowgacha; district: Jessore), Kathgora *Baor* (Upazila: Moheshpur; district: Jhenaidah), Fatehpur *Baor* (upazila: Moheshpur; district: Jhenaidah), Joydia *Baor* (upazila: Kotchandpur; district: Jhenaidah), Baluhar *Baor* (Upazila: Kotchandpur; district: Jhenaidah), Marjad *Baor* (upazila: Chowgacha and Kaliganj; district: Jessore and Jhenaidah) from south-western part of Bangladesh.

Based on reconnaissance visits, 20 sites were selected for sampling from each selected lake, sites separated 200 - 800 m. Samplings of water were carried out twice between June 2009 and March 2010, covering the rainy monsoon season (June - October, 2009) and the cool dry winter season (November 2009 - March, 2010). Hence, 240 water samples were analysed (6 lakes × 20 samples × 2 seasons).

Water quality indicating physico-chemical parameters such as transparency, temperature, conductivity, pH, dissolved oxygen (DO), calcium (Ca) hardness, chlorophyll-*a* (chl *a*), total nitrogen (TN) and total phosphorus (TP) of water were studied using the standard methods⁽³⁾. Water temperature was measured once with a digital thermometer. A fluorometer (Aquafluor Handheld Fluorometer, Turner Designs,

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Sunnyvale, CA, USA) was used for ≥ 3 measurements of chl-*a* concentration/site. Concentration of dissolved oxygen (DO), pH, and conductivity were measured using hand-held DO (DO₂ Meter 9200; Jenway, Stone, UK), pH (eco Testr pH2, Vernon Hills, IL, USA) and conductivity (EC Testr 11+ Eutech instrument) meters. From each site, Secchi depth, TP (HACH Lange Test Kit; HACH Corporation, Loveland, Colorado), TN (HACH Lange Test Kit), and Ca (HACH Lange Test Kit) were recorded⁽³⁾.

During the study period the lowest and highest mean value of transparency were recorded as 8.28 ± 0.34 and 22.70 ± 0.58 from Fatehpur *Baor* and Marjad *Baor*, respectively (Table 1). As the p value was < 0.05 at the significance level $\alpha = 0.05$, there was significant difference of means of the transparency value in the six *Baors*. Transparency of water varies with different factors such as silt, microscopic organisms, suspended organic matter, seasons of the year, latitude and intensity of light, application of manure, grazing pressure of fishes or shellfishes and rainfall^(4, 5).

Temperature is an important parameter in limnological studies, since it affects the distribution of organisms, density of water and solubility of gases and minerals⁽⁴⁾. Variation of temperature ($^{\circ}\text{C}$) of *Baors* ranged from 18 - 34 $^{\circ}\text{C}$ with the mean value 27.52 ± 0.29 . There was no significant difference ($p > 0.05$) of means of temperature of the *Baors*. Water temperature is the environmental physical parameter which affects most of the organisms^(6, 7). Generally 20 - 30 $^{\circ}\text{C}$ is the temperature requirement for warm water fishes and for prawn culture the suitable temperature range is 21.9 - 33.5 $^{\circ}\text{C}$ ^(7, 8). Therefore, the temperature recorded from the six *Baors* was suitable for aquatic life forms.

The maximum mean value of conductivity ($\mu\text{S}/\text{cm}$) was recorded as 626.67 ± 40.77 from Fatehpur *Baor* and minimum mean value was recorded as 129.52 ± 15.64 from Kathgara *Baor* (Table 1). Significant difference ($p < 0.05$) exists in the measured conductivity of the *Baors*. According to Lawson (1997) distilled water has a conductivity of about 1 $\mu\text{S}/\text{cm}$ while natural freshwaters have conductivities ranging from 20 - 1,500 $\mu\text{S}/\text{cm}$ ⁽⁶⁾. Therefore, the observed conductivity of the six *Baors* was within expected range.

The value of pH ranged from 6.89 - 10.9 with the highest mean value 9.30 ± 0.13 recorded from Fatehpur *Baor* and lowest mean value 7.62 ± 0.07 recorded from Marjad *Baor* (Table 1). The mean value of pH 8.29 ± 0.04 recorded in the present study showed that the water of the six *baors* was alkaline in nature. Kabir and Naser (2011) made similar observations from the *Chandbill* oxbow lake⁽²⁾. According to Trivedi and Raj (1992), the optimum pH range for aquatic life varied from 6.8 to 9.0⁽⁸⁾. In this study, Ca hardness (mg/l) ranged from 47 - 322 mg/l in two seasons. The minimum mean value 78.25 ± 3.32 was recorded from Marjad *Baor* while maximum mean value 228.98 ± 9.69 was recorded from Fatehpur *Baor* (Table 1). High significant difference ($p < 0.05$) of the means of Ca hardness measurements of the *Baors* was evident.

Table 1. GPS location of six *Baors* and observed water quality parameters ($\bar{x} \pm SE$).

| Oxbow lakes (<i>Baors</i>) | GPS location | Transparency (cm) | Temperature (°C) | Conductivity ($\mu S/cm$) | pH | DO (mg/l) | Ca hardness (mg/l) | Chl- <i>a</i> ($\mu g/l$) | TN (mg/l) | TP (mg/l) |
|------------------------------|-----------------------------------|-------------------|------------------|-----------------------------|-----------|-----------|--------------------|-----------------------------|-----------|-----------|
| Marjad | N 23° 18'10.0"; E 89° 06'09.4" | 8.28±0.34 | 25.17±0.76 | 129.52±2.44 | 7.62±0.07 | 4.60±0.32 | 78.25±3.32 | 4.46±0.29 | 1.94±0.13 | 0.07±0.01 |
| Bergobindo pur | N 23° 13'25.6"; E 89° 01'49.4" | 11.73±0.28 | 26.74±0.73 | 256.76±5.71 | 7.88±0.06 | 5.32±0.37 | 109.03±1.37 | 7.62±0.43 | 2.62±0.10 | 0.12±0.00 |
| Kathgara | N 23° 16'57.1"; E 88° 57'06.0" | 13.47±0.36 | 27.43±0.72 | 319.65±4.94 | 8.09±0.05 | 5.89±0.41 | 120.08±0.72 | 9.52±0.48 | 3.49±0.12 | 0.15±0.00 |
| Baluhar | N 23° 24'26.8"; E 88° 59'47.4" | 15.47±0.47 | 28.05±0.69 | 345.18±2.92 | 8.31±0.06 | 6.58±0.43 | 134.43±1.61 | 11.34±0.55 | 4.17±0.14 | 0.18±0.00 |
| Joydia | N 23° 26'40.6"; E 88° 55'47.4" | 17.93±0.46 | 28.53±0.67 | 377.35±5.31 | 8.57±0.06 | 7.07±0.48 | 152.98±1.77 | 13.56±0.65 | 5.15±0.16 | 0.21±0.00 |
| Fatehpur | N 23° 22'26.8"; E 88° 54'09.3" | 22.70±0.58 | 29.17±0.68 | 625.59±6.84 | 9.30±0.13 | 8.82±0.63 | 228.98±9.69 | 15.56±0.51 | 6.83±0.21 | 0.27±0.00 |

Dissolved oxygen content was found to fluctuate from 6 - 18 mg/l with a minimum mean value 4.60 ± 0.32 recorded from Marjad *Baor* and maximum mean value 8.82 ± 0.63 from Fatehpur *Baor* (Table 1). This observation has similarity with the findings of Kabir and Naser (2011)⁽²⁾. There is no significant difference ($p > 0.05$) of means of DO between the *Baors*. Generally, a minimum DO concentration of 5 mg/l is recommended for warm-water fish and 6 mg/l for cold water species^(6,7). Also Lawson (1997) mentioned that small differences in the metabolic rate of an aquatic community can cause rapid changes in DO concentrations⁽⁶⁾.

Chlorophyll-*a* is common in all photosynthesizing plants. For this reason, the amount of planktonic (suspended) algae in a lake is estimated by using chlorophyll-*a* concentration⁽¹⁰⁾. In this study, chlorophyll-*a* ranged from 2.02 - 18.45 $\mu\text{g/l}$ with the minimum mean value 4.46 ± 0.29 recorded from Marjad *Baor* and maximum mean value 15.56 ± 0.51 Fatehpur *Baor* (Table 1). Significant difference ($p < 0.05$) of means of Chl-*a* of the selected six *baors* was evident.

The TN content recorded in this study ranged from 2 - 10 mg/l with the minimum mean value of 1.94 ± 0.13 observed in Marjad *Baor* and maximum value 6.83 ± 0.21 observed in Fatehpur *Baor* (Table 1). There was significant difference ($p < 0.05$) of means of TN observed in the six *Baors*. According to water quality parameters and indicators: Fact Sheet 2, the range of TN includes < 0.5 mg/l (low), 0.5 - 1 mg/l (medium), $>1 - 3$ mg/l (high) and > 3 (very high)⁽⁹⁾. The standard range of nitrate for most of the organisms' survival is 0 - 3.0 mg/l⁽⁷⁾. The water of the selected six *Baors* was observed as very high in TN content. From this study the TP (mg/l) ranged from 0.1 - 0.28 mg/l with the minimum mean value of 0.07 ± 0.01 recorded from Marjad *Baor* and maximum mean value 0.27 ± 0.00 recorded from Fatehpur *Baor* (Table 1). Significant difference ($p < 0.05$) of mean values of TP contents reported from the six *Baors* was observed. TP concentrations above 0.030 mg/l are enough to stimulate nuisance algae growth water quality standard for lakes is 0.050 mg/l TP^(9,10).

An understanding on water quality parameters becomes increasingly important for lake management. Therefore, this study can be used as a baseline study for further research and actions for effective *Baor* management.

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