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COMPARATIVE ANALYSIS OF SOME WATER QUALITY PARAMETERS OF THREE LAKES IN JAHANGIRNAGAR UNIVERSITY CAMPUS, SAVAR, BANGLADESH

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Abstract: Study was conducted to determine the physico-chemical parameters of water of three different lakes in Jahangirnagar University campus from March to November, 2013. The selected parameters were water depth, water temperature, conductivity, transparency, pH, dissolve O_2, free CO_2, total alkalinity, hardness, sulfate and water color. Water depth fluctuated from 140 cm to 385 cm, temperature ranged from 25 ^{0}C to 31 ^{0}C, conductivities ranged from 627 µS/cm to 1544 µS/cm, transparency from 22 cm to 87 cm, considerable variation of water colors were found and pH ranged from 6.4 to 7.5 without having any significant fluctuation. Dissolve oxygen (DO) ranged from 2.7 mg/l to 7.6 mg/l, carbon dioxide level ranged from 16 mg/l to 62 mg/l, total alkalinity and hardness were ranged from 43 mg/l to 92 mg/l and 63 mg/l to 134 mg/l, respectively with slight variations in different lakes in different months. During the study period, all the spots showed minimum fluctuation of physico-chemical parameters from the normal range without having some exceptions.

Key words: Physico-chemical parameters, water, lakes, fluctuation

INTRODUCTION

Lakes and surface water reservoirs are considered as one of the planet's most important freshwater resources and provide innumerable benefits. Lakes are stagnant surface water bodies, receive and stores rain fall water. The entire life of the world depends on water and therefore the hydrological study is very essential to comprehend the relationship among its diverse trophic levels and food webs (Soundarapandian *et al.* 2009). Distribution and productivity levels of organisms are largely determined by physico-chemical factors (Ashton and Schoeman 1983). The physical and chemical characteristics of water are important parameters as they directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals (Swingle 1969).

Increased anthropogenic activities in and around the water bodies damage the aquatic ecosystems and ultimately the physico-chemical properties of water (Upadhyay *et al.* 2010). It is well established that domestic sewage and industrial effluents falling into natural water bodies change the water quality

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and lead to eutrophication (Shaw *et al.* 1991). The monitoring of physico-chemical parameters of a water body is vital for both long term and short term study (Wood 1995). Good water quality resources depends on a large number of physico-chemical parameters and the magnitude and source of any pollution load; and to assess that, monitoring of these parameters are essential (Reddi *et al.* 1993).

Study on physico-chemical parameters of lake is very important from biological as well as environmental point of view. The lakes of Jahangirnagar University campus are ideal place. Some of these lakes are also used for pisciculture purpose. These lakes provide habitat for migratory birds in winter season which has aesthetic value, so it is important to study the physico-chemical parameters of water. There are a few works on physico-chemical condition of different lakes in Jahangirnagar University campus but there are many works on this topic in various wetlands of Bangladesh and abroad (Alikunhi 1957, Huet 1972, Begum *et al.* 1989, Sahu *et al.* 2007, Shahin *et al.* 2011, etc.).

The objectives of this study is to know the present status of physico-chemical parameters of water of the 3 selected lakes in Jahangirnagar University (JU) campus, to assess their interrelationship and to compare the present results with results obtained previously in the lakes of JU campus as well as other lakes in home and abroad.

MATERIAL AND METHODS

The present study area was three lakes in Jahangirnagar University campus which is situated about 32 km away in the north-western side of capital city Dhaka.

There are 22 wetlands within the campus of which three lakes were selected. These lakes are, adjacent to – 01. Jahanara Imam Hall (Lake 1), GPS location: 23°88'56.81" N and 90°26'80.46" E, 02. Transport (Lake 2), GPS location: 23°88'36.4" N and 90°26'75.09" E and 03. New Arts Building (Lake 3), GPS location: 23°88'17.76" N and 90°26'85.18" E (Fig. 1). For the estimation of physico-chemical parameters, data were collected on monthly basis and between 6 a.m. to 8 a.m. for a period of 9 months from March to November 2013.

During the study period the data from Lake 3 was not collected during the month of March, due to dredging of that site. Samples were also collected with dark plastic bottle for laboratory experiment at a depth of 5 cm. The water temperature, color, and turbidity were measured on spot. The remaining parameters were analyzed immediately after returning to the Fisheries Laboratory of Zoology Department of Jahangirnagar University.

Fig. 1. Aerial map of the study area

The water depth was measured using a rope along with a medium sized stone tied at one end of it and a meter tape. Water temperature was recorded with the help of a centigrade thermometer. Water color was recorded depending on visual appearance. The conductivity was measured with the help of "Pocket Multiparameter" and recorded (Eutech Instruments, Singapore; model: PCS T). Transparency of three lakes was recorded with the help of Secchi disc.

All the chemical parameters were analyzed in the laboratory after collecting the sampling water by using water analysis kit. Hydrogen-ion-concentration (pH) of the water body was analyzed with the help of pH meter "Pocket Multiparameter" (Eutech Instruments, Singapore; model: PCST). The determination of dissolved oxygen or DO was done by standard protocols of APHA (2001), which was carried out by Pocket Colorimeter (Digital–programmed, HACH Company, USA). Titrimetric methods (Welch 1948) were used to

determine free CO_2, alkalinity and hardness using "Field water analysis kit" of HACH Company, USA. Sulfate test was done with the help of HANNA test kit following standard protocols (APHA 2001). GPS coordinates were taken by GPS meter (GARMIN GPSMAP 62s). Statistical analysis was done using Microsoft Office Excel 2007 and SPSS (Version 11.5).

RESULTS AND DISCUSSION

During the 9 months of study period, different physico-chemical parameters of water were monitored from 3 selected lakes of Jahangirnagar University campus with a view to show monthly fluctuation of these parameters as well as their interrelationship.

The maximum water depth was 385 cm, and was found in August at Lake 3 and minimum depth was 140 cm in March at Lake 2 (Table 1). The maximum depth (Mean ± Standard Error/$\bar{x} \pm SE$) was found at Lake 3 (306±17.388 cm) and minimum (164.17±5.472 cm) at Lake 2 (Table 2). The depth of water at a particular site in a water body is one of the major physical factors which act as a controlling factor for determining the water quality (Shah and Pandit 2012).

Among 3 sampling spots the water temperature was ranged from 25 to 31 ^{0}C (Table 1). The fluctuation of water temperature usually depends on the season, geographic location, sampling time and temperature of effluents entering the stream (Ahipathy and Puttaiah 2006). During my study period it was found that, the mean temperature (± Standard Error) at Lake 3 was higher (29.5±0.482 ^{0}C) than that of other two spots (Table 2). Kerketta *et al.* (2013) recorded the similar result in a study of drinking water from different sources in and around Ranchi, Jharkhand, India. Mishra and Bhatt (2008), found almost the same result in V.V. Nagar and nearby places of Anand district, Gujarat.

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Table 1. Monthly fluctuations of physico-chemical parameters from March to November, 2013

	Parameters	Water depth	Water temperature	Conductivity	Transparency	Water color	pH	Dissolve O_2 (DO)	Free CO_2	Total alkalinity	Hardness	Sulfate
	Unit	cm	^{0}C	µS/cm	cm	Visual appearance	pH	mg/L	mg/L	mg/L	mg/L	mg/L
Lake 3	November	245	28.5	1112	**87**	Blackish	7.1	6.8	42	78	108	48
	October	290	30	836	86	Blackish	6.8	6.9	45	75	112	39
	September	315	**31**	789	81	Blackish	7	5.5	38	57	107	31
	August	**385**	**31**	**627**	75	Transparent	7.2	6.3	32	**43**	78	28
	July	354	31	748	36	Transparent	**7.5**	6.5	33	54	86	**26**
	June	323	30	750	22.3	Ash	6.7	7.2	17	55	98	34
	May	292	28	790	**22**	Ash	7.3	7	22	67	68	28
	April	244	28	872	24	Ash	**7.5**	**7.6**	20	76	**63**	32
	March	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lake 2	November	154	28	1543	75.5	Blackish	7	4.1	**62**	66	123	64
	October	168	29	1342	68	Blackish	6.8	3.2	60	62	102	51
	September	187	30.5	1296	56	Reddish Black	7	2.8	43	57	98	43
	August	175	30	738	56	Reddish	6.5	4	28	58	85	37
	July	178	29	1065	74	Blackish	7.1	5	23	44	98	38

	Parameters	Water depth	Water temperature	Conductivity	Transparency	Water color	pH	Dissolve O_2 (DO)	Free CO_2	Total alkalinity	Hardness	Sulfate
	Unit	cm	^{0}C	µS/cm	cm	Visual appearance	pH	mg/L	mg/L	mg/L	mg/L	mg/L
Lake 1	June	178	29.3	1166	65.5	Ash	6.8	5.2	24	58	106	45
	May	154	28	988	69	Blackish	6.5	7	23	54	90	54
	April	146	27	1250	63	Transparent	7	6	22	77	121	60
	March	**140**	**25**	1241	61.5	Blackish	7.1	5.6	20	**92**	105	65
	November	158	28	**1544**	70	Blackish	7.4	4	58	68	**134**	**76**
	October	175	29	1413	61	Blackish	6.9	**2.7**	55	59	112	58
	September	193	30.5	1265	54.4	Reddish black	7.1	3.4	55	55	90	45
	August	190	30	836	77	Reddish black	6.8	4.2	45	58	88	38
	July	180	29	955	62	Blackish	**6**	4.5	28	53	103	43
	June	175	29.3	1232	60.5	Ash	7	5.7	**16**	62	90	51
	May	160	27.5	1110	69.5	Transparent	6.8	6.1	24	56	115	56
	April	155	27	1278	58.5	Blackish	7.2	5.8	23	70	98	61
	March	149	**25**	990	56	Blackish	7	6.2	19	85	119	68

ND= Not Detected, the maximum and minimum values of the parameters are shown in bold

Table 2. Mean ± Standard Error ($\bar{x} \pm SE$) of the physico-chemical parameters of water among three different lakes

Parameters	Lake 1	Lake 2	Lake 3
Water depth (cm)	170.556±5.252	16.417±5.472	306±17.388
Water temperature (^{0}C)	28.306±0.546	1.638±0.546	29.5±0.482
Conductivity (µS/cm)	1180.333±76.037	230.686±76.895	815.5±49.508
Transparency (cm)	63.211±2.476	7.067±2.356	54.031±10.805
pH	6.956±0.094	0.234±0.078	7.131±0.104
Dissolve O_2 (DO) (mg/L)	4.733±0.423	1.36±0.453	6.725±0.225
Free CO_2 (mg/L)	35.889±5.717	16.804±5.601	31.125±3.705
Total alkalinity (mg/L)	62.889±3.36	14.031±4.677	63.125±4.502
Hardness (mg/L)	105.444±5.239	12.654±4.218	90±6.727
Sulfate (mg/L)	55.111±4.091	10.721±3.574	33.25±2.555

Maximum conductivity was found in November (1544 µS/cm) at Lake 1 and minimum was in August at Lake 3 (627 µS/cm) (Table 1) with the maximum ($\bar{x} \pm SE$) conductivity at Lake 1 (1180.333±76.037 µS/cm) (Table 2). During my study period it was found that, the conductivity of water at Lake 3 was around preferable range but it was higher at Lake 1 and 2. Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions; on their total concentration, mobility, and valence; and on the temperature of measurement (Sripathy *et al.* 2012). Conductivity outside the range between 150 and 500 µs/cm of inland fresh waters could indicate that, the water is not suitable for certain species of fish or macro-invertebrates (APHA 1992).

At the present study, transparencies of 3 sampling spots (Lakes) were varied from 22 cm to 87 cm (Table 1). Transparency in water is caused by suspended and colloidal matter such as clay, silts, finely divided organic and inorganic matter, paint and other microscopic organisms. Transparency ranged from 15 to 40 cm is considered good for fish culture (Boyd 1982). The wide range of transparency at present study was due to the less colloidal matter in water of Lake 3. Kabir and Naser (2011) observed almost the similar Secchi depth (8.89 to 53.34 cm) in Chandbill oxbow lake of Meherpur, Bangladesh.

Within the present study area, the pH values ranged from 6.4 to 7.5 (Table 1), with maximum ($\bar{x} \pm SE$) pH (7.131±0.104) at Lake 3 (Table 2). Similar results were also recorded by Sultana and Huda (2013) in the wetlands of Jahangirnagar University campus. The present result is also supported by the result (pH 6.99 to 7.0075) obtained by Medudhula *et al.* (2012) from lower manair reservoir of Karimnagar district, Andhra Pradesh. According to WHO (1984), water pH ranging from 6.5 to 8.5 is best. Without the value recorded at spot 1 in July (pH 6.4), the pH values of all the samples were within the pH range.

In the present study the dissolve oxygen (DO) ranged from 2.7 mg/l to 7.6 mg/l (Table 1) during the sampling months with maximum ($\bar{x} \pm SE$) DO (6.725±0.225 mg/l) recorded from Lake 3 (Table 2). The Lake 3 was always rich in DO but Lake 1 was poor. Similar result (6.25 mg/l) was also observed by Chowdhury and Mazumder (1981) in Kaptai Lake. Seasonal variation of dissolved oxygen is mainly due to freshwater flow and terrigenous impact of sediments (Paramasivam and Kannan 2005). DoF (1996) reported that the range of dissolve oxygen suitable for fish culture is 5 mg/l to 8 mg/l. Sahu *et al.* (2007) also found the same result (1.3 to 6.5 mg/l) in Madhaya Pradesh, India. From the above discussion it can be said that DO was not always within the optimum level.

The high value of the free carbon dioxide content is an indication of high degree of pollution, a fact also supported by Todda (1970) and Coole (1979) which related high value of free carbon dioxide content to high degree of pollution. Present study found that, the free CO_2 ranged from 16 mg/l to 62 mg/l (Table 1). The average maximum (35.889±5.717 mg/l) and minimum (16.804±5.601 mg/l) free CO_2 was recorded from Lake 1 and 2 respectively (Table 2). This finding is similar to Sahu *et al.* (2007) (5.6 to 52.4 mg/l) which was conducted in Madhaya Pradesh. Laksminarayan (1965) observed the similar result in the river Ganges, Varanasi, India.

Alikunhi (1957) has stated that, alkalinity greater than 100 mg/l is suggestive of highly productive waters. During the study period at different sampling spots (Lakes), the total alkalinity ranged from 43 to 92 mg/l (Table 1) with maximum value (63.125±4.502 mg/l) at Lake 3 (Table 2). So, the alkalinity range of present study area is within the productive level. However, similar values (85±9.563 mg/l) were observed in Safilguda Lakewater of Hyderabad by Chandrasekhar and Hakcel (2008).

In the present study the concentration of hardness ranged from 63 mg/l to 134mg/l (Table 1) with average maximum value (105.444±5.239 mg/l) at Lake 1 (Table 2). Similar findings were observed by Sultana and Huda (2013) in the wetlands of Jahangirnagar University campus and Kumar and Oomen (2011) in water bodies of Gujarat, India. Calcium and magnesium are essential to fish for metabolic reactions such as bone and scale formation. Kannan (1991) has classified water on the basis of hardness in the following manner; 0-60 mg/l soft, 61-120 mg/l moderately hard, 121-160 mg/l hard and greater than 180 mg/l very hard. Hardness below 300 mg/l is considered potable but beyond this limits cause gastro-intestinal irritation (ICMR 1975).

The lowest values of sulfate (SO_4^{2-}) found 26 mg/l in July at Lake 3 and maximum value was recorded at Lake 1 in November and it was 76 mg/l (Table 1). Maximum average sulfate was recorded from Lake 1 and it was 55.111±4.091 mg/l (Table 2). The sulfate content may be due to decay of phytoplankton and aquatic macrophytes or due to the oxidation of sulphide or sulphite to sulphate in the presence of photosynthetic sulphur bacteria (Dunette *et al.* 1985). Similar

findings were found in the northern reservoir of Dumat Lake in Al-Jouf Region, Saudi Arabia by Aqel (2012).

Reid (1961) classified the true color of water due to presence of plankton and other dissolved organic materials as a productive one and apparent color produced by the reflection of sky and surroundings as an unproductive water body. In this study, the color of water varied from spot to spot and month to month. The major color found were: blackish, black, ash, reddish and reddish black (Table 1). But transparent water was also recorded during the study period which is not resembled to any color.

The interrelationship among the physico-chemical parameters of water were analyzed at 5% significant level. Water depth showed strongly positive correlation with water temperature for all three Lakes and showed significant negative correlation with conductivity at Lake 3, with total alkalinity at all three Lakes, with hardness at Lake 1, and with sulfate of both Lake 1 (r= -0.854) and Lake 2 (r= -0.896).

On the other hand, water temperature showed significant negative correlation with dissolve oxygen at Lake 1 (r= -0.682) and Lake 3 (r= -0.774), with total alkalinity for all three Lakes, with sulfate at Lake 1 and 2. Conductivity showed significant positive correlation with pH at Lake 1 (r= 0.7124), with total alkalinity at Lake 3 (r= 0.8322), with hardness at Lake 2 (r= 0.8087).

Conductivity showed strong positive correlation with sulfate at Lake 3 (r= 0.8533), while pH showed significant negative correlation with hardness at Lake 3 (r= -0.726). pH was positively correlated with sulfate at Lake 1 (r= 0.6738). Transparency showed significant positive correlation with free CO_2 at Lake 3 (r= 0.9126) and with hardness at the same Lake (r= 0.6976). Dissolve oxygen (DO) showed significant negative correlation with free CO_2 at Lake 1 (r= -0.905) and Lake 2 (r= -0.713).

CONCLUSION

These lakes are very important for ecosystem. The present study has revealed that, the conductivity of water fluctuated much above the limit required for the aquatic organisms whereas; the dissolved oxygen (DO) of Lake 1 and 2 was very poor. From the above results and discussion it has been clear that, except for Lake 3 the lakes are not as much productive as expected in case of DO and conductivity. The commercial fish culture may exert bad effect on physico-chemical parameters of these water bodies. Still it has the time to conserve the water quality and is very much necessary to conduct more research on these lakes and to take proper steps to maintain the physico-chemical parameters of water at healthy state.

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