Research Article
Volume 11:S6, 2021

Environmental & Analytical Toxicology

ISSN: 2161-0525 Open Access

Investigation of Heavy Metals in Jahangirnagar University Lakes Water in Bangladesh

Sumon Deb Nath[1*], Tasrina Rabia Choudhury[2] and Rabindra Chandra Sinha[3]

[1]*Department of Physics, Khulna University of Engineering and Technology, Khulna, Bangladesh*

[2]*Department of Chemistry, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh*

[3]*Department of Physics, Jahangirnagar University, Dhaka, Bangladesh*

Abstract

Using flame atomic absorption spectrophotometer (FAAS), concentration of toxic metals Pb, Cd, Cr, Cu, Fe, Mn and Zn in two Jahangirnagar University lakes were determined. For Lake-1, concentration ranged as 0.021 to 0.031 mg/l for Pb, 0.6 to 1.029 mg/l for Fe, 0.006 to 0.09 mg/l for Mn and 0.0042 to 0.0069 mg/l for Zn. For Lake-2, concentration ranged as 0.028 to 0.032 mg/l for Pb, 0.593 to 0.682 mg/l for Fe, 0.069 to 0.116 mg/l for Mn and 0.0019 to 0.004 mg/l for Zn. Cd, Cr and Cu were found below the detection limit both in Lake-1 and Lake-2. For Lake-1, the observed pH and TDS ranges 7.33-7.37 and 126-156 mg/l respectively. For Lake-2, the observed pH and TDs ranges as 7.31-7.37 and 129-152 mg/l respectively. Insignificant correlation was found among the heavy metals in Lake-1. For Lake-2, Pb and Mn show significant positive correlations among themselves and negative correlations with Fe and Zn. Iron (Fe) is more than the recommended value of WHO as we as Bangladeshi drinking standards, would pose a serious problem for aquatic lives as well as human health. Monitoring of contaminant discharge at JU Lakes should be launched for future remediation as well as the management strategies.

Keywords: Trace elements • Water pollution • Toxicity • Aquatic lives • Correlation

Introduction

Recently, research has been focused on the toxicity of metal pollution in aquatic environment. Toxicity effects can be classified as follows: one is acute effects which appear instantly after exposure and another one is chronic effects that may be bloomed many years later whose origins are very hard to find out [1]. A large amount of toxic trace metals is released by atmospheric deposition as well as human activities which avail metal contamination in rural and remote aquatic environments [2]. Some toxic trace elements in water cause various problems in human health which varying from shortness of breath to different types of cancer through drinking water [3]. Least developing countries as well as developing countries like Bangladesh are facing difficulties with toxic trace metal contaminations [4]. The major sources of heavy metals are acid mine discharges, automobiles, pesticides, industrial discharge, sewage sludge etc. that causes very dangerous aquatic environment pollution [5]. The domestic products like lotion, shampoo, moisturizer, hair dye, laundry detergent, human waste etc. also responsible for contaminating the lake water. Lakes are liable for various ecosystem services like climate monitoring, water cycling, and providing habitat for organisms [5]. Njogu et al., studied the distribution of heavy Metals in various Lake matrices of the Lake Naivasha Basin, Kenya and found the heavy metal concentrations for water as follows 0.0166 mg/l for Pb, 0.01269 mg/l for Cd, 0.00134 mg/l, 0.00568 mg/l for Cu, and 0.48 mg/l for Zn, respectively. Quraishi et al., investigated the season and year-wise distributions of some trace metals and anions in Gulshan Lake, Bangladesh and found Pb, Cd, Cr, and Cu level below the detection limit. The concentration ranges of other metals were 0.17-1.28 mg/l for Fe, 0.03-0.19 mg/l for Mn, and 0.024 – 0.063 mg/l for Zn respectively. Radulescu et al., determined the heavy metal concentrations in water and mud by atomic absorption spectrometry and found that Fe concentrations were higher in mud in compare with water samples. Kotteeswaran et al., analysed some heavy metals in water from Pulliyankannu Lake Tamilnadu in India and found the concentrations of Al, Cd, Cr, Cu, Fe, Mn, Pb and Zn were 1.804 mg/l, 0.022 mg/l, 0.642 mg/l, 1.611 mg/l, 2.364 mg/l, 1.944 mg/l, 0.153 mg/l and 0.358 mg/l respectively. The Jahangirnagar University (JU) is only residential university of Bangladesh which has a large number of beautiful lakes. In winter season, the lakes provide a safe sanctuary for the migratory birds which comes from China, Siberia, Himalayans, Mongolia, and other cold territories. The lakes also used for pisciculture purpose [6]. Realizing the importance of the problem that may exists due to excess toxic trace elements as well as physico-

***Address to Correspondence:** Dr Sumon Deb Nath, Department of Physics, Khulna University of Engineering and Technology, Khulna, Bangladesh, Tel: 880 1303 428406; E-mail: sumon.physics@phy.kuet.ac.bd*

Received: 29 July, 2021; **Accepted:** 12 August, 2021; **Published:** 19 August, 2021

chemical parameters like temperature, pH, TDS, the present research was studied through water. To ensure sound quality of life, regular monitoring of pollution sources is needed. It could be an effective attempt to enrich the awareness of the people to restore the natural sources and to track toxic trace metal concentration along with pH and TDS of drinking water and their effects on human health as well as the aquatic lives.

Materials and Methods

Sampling

The lakes water samples were collected into 10-15 cm depth by grab method from Lake-1 and Lake-2 repectively. 2L polyethylene white bottles were used for collecting samples from different selected spots and then filtered through Whatman filter paper. After cleaning, filtered water samples were taken into 1 liter polyethylene white bottles. For cationic species experiment, 1 bottle was acidified with 4 ml 69%-70% Analar Nitric Acid (E. Merck, Germany) to make the pH<2 of the samples. The acidified samples were kept in refrigerators at 40°C for further analysis. Before experimental analysis, the samples were taken to the normal temperature. The rest of the samples were stored at room temperature at 25°C for determining pH and TDS [7].

Sample stations

The GPS location (i) Lake-1: 23°88′36.4" N and 90°26'75.09" E and (ii) for Lake-2: 23°88'56.81" N and 90°26'80.46" E. Four sampling station were marked as St-1, St-2, St-3, and St-4 for Lake-1 and St-1, St-2, St-3, and St-4, for Lake-2 which are shown in Figure 1.

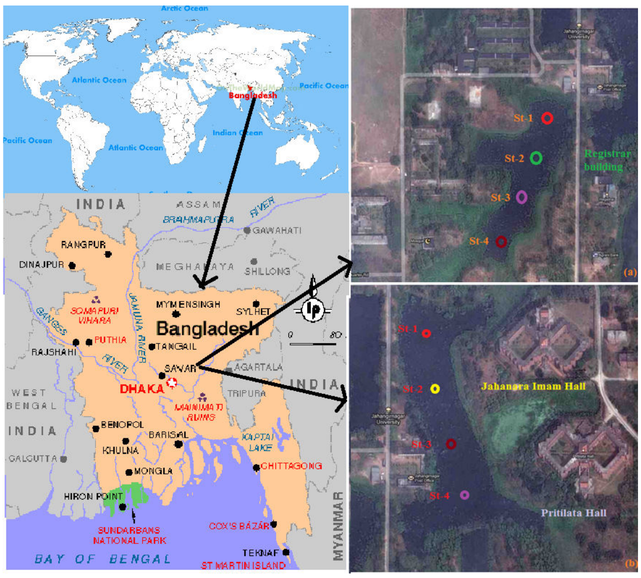

Figure 1. Google view of the four sampling spots of jahangirnagar university (a) Lake-1 and (b) Lake-2.

Sample analysis

Trace metal concentrations were measured in the Chemistry Division, Bangladesh Atomic Energy Commission, Dhaka. Seven individual standard solutions i.e. Pb, Cd, Cr, Cu, Fe, Mn and Zn and concentrated nitric acid were purchased from E. Merck Germany [8]. FAAS (Varian SpectrAA-240) was used to determine the concentrations of the trace metals of water samples which were pre-concentrated by evaporating the sample to low volume on a hot plate. 2 ml Analar grade nitric acid was added before heating the organic matter. Water is relatively clean with low total dissolved solids content water can be used directly into the instrument. After concentrated the sample was filtered by Whatman 41 filter paper. A volume of 250 ml of the acidified sample was taken into a 300 mL beaker and then

heated on a hotplate with 4 mL of concentrated HNO3 until the total volume was reduced to 10 ml (appriximately). The concentrated sample was then transferred to a 25 mL volumetric flask and made up to volume for metal analysis by FAAS. pH was determined by pH meter (Model: Ecodcon) and TDS (Total Dissolved Solids) was measured by a TDS meter (Model 4510, JENWAY) in the department of Environmental Science, Jahangirnagar University, Savar, Dhaka.

Statistical analysis

All graphs were plotted using Origin Pro (8.5 version) software. Standard deviation and mean were calculated to show the average behavior of the parameters as well as the dispersion. Pearson’s correlation (r) represented the association among the parameters. All statistical analysis was performed with SPSS (23.0 version) software.

Results and Discussion

pH and TDS

pH and TDS of the two JU Lakes water were measured during our study period which are tabulated in Table 1, Figure 2.

Table 1. Descriptive statistics of the physicochemical parameter of the lakes water.

Parameters	N	Min.	Max.	Mean	SD
pH	8	7.31	7.37	7.34	0.022
TDS (mg/l)	8	126	156	139.88	11.87

Min.=Minimum, Max.=Maximum, SD=Standard Deviation

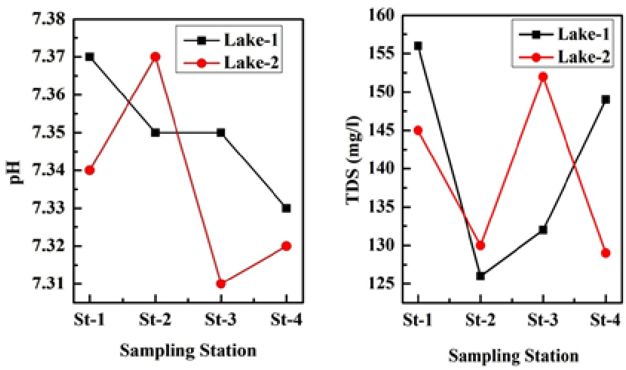

Figure 2. Variation of (a) pH and (b) TDS in different sampling stations.

Figure 2 (a) demonstrates the maximum (pH=7.37) and minimum value (pH=7.31) was found in station-2 and station-3 repectively for lake-2. pH value for lake-1 was varied in between 7.31 to 7.37. So, observed pH value within safer limit as prescribed in WHO and Bangladeshi standard. During the study period the water was dark and smell is basic because it contains a higher concentration of [OH-][9]. However, pH values ranged as 6.4 to 7.5 were found in JU Lake water by Rahman et al. Figure 2(b) shows the maximum (TDS=156 mg/l) and minimum value (TDS=126 mg/l) was found in station-1 and station-2 repectively for lake-1 and TDS value for lake-2 was varied in between maximum to minimum value of lake-1. TDS from natural sources have been found <30 mg/l<6000 mg/l [10]. In our study the TDS varied from 126 to 156 mg/l in JU lakes.

Low TDS means the other heavy elements except seven determined elements may be present in low concentration in the JU lakes water. In addition with pH and TDS, water temperature is another vital parameter to understand water environment. Drastic changes of water temperature are harmful for human and aquatic life especially for fishes and migratory birds in JU lakes. Oxygen level of cold water is more than warm water that is very important for aquatic life [11].

Heavy metals

Lake ecosystems are endangered to heavy metal pollution. Heavy metal concentrations in the two JU Lakes water were investigated during rainy seasons. Descriptive statistics of heavy metals of two JU Lakes water.

The comparison of two JU Lakes water with some drinking water standards is shown in (Figure 3).

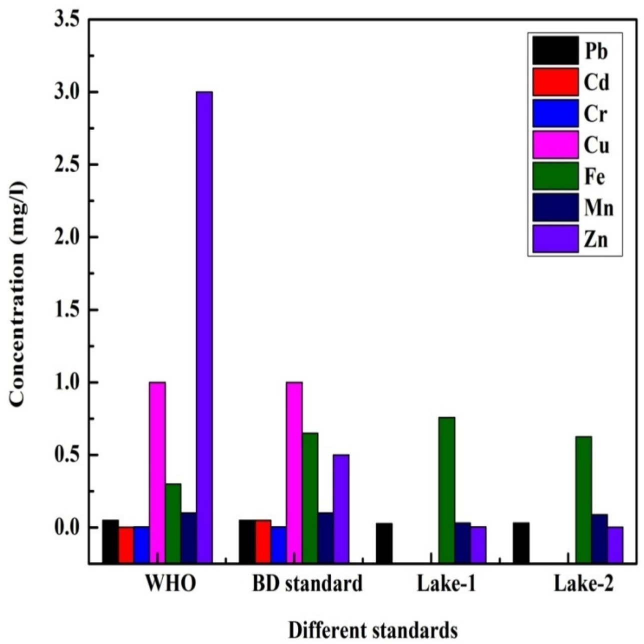

Figure 3. Comparison of two JU lakes water with some drinking water standards.

Lead

Pb is classified into a rare element because it content of igneous rocks is about 0.0015 mg/l. The half-life perid of Pb in blood is near about 30 days and in the skeleton 20-30 year. The vital health effect of Pb poisoning may causes to anemia, constipation, headache, insomnia, loss of appetite, metallic taste pain in abdomen, arteriosclerosis, hypertension, miscarriages, loss of vision, joints painful, diminished hemoglobin, etc. [12]. We found the Pb concentration ranges as 0.021 to 0.031 mg/l in Lake 1 and 0.028 to 0.032 mg/l in Lake-2 that was below the permissible value of WHO and Bangladeshi standard [13] (Figure 4).

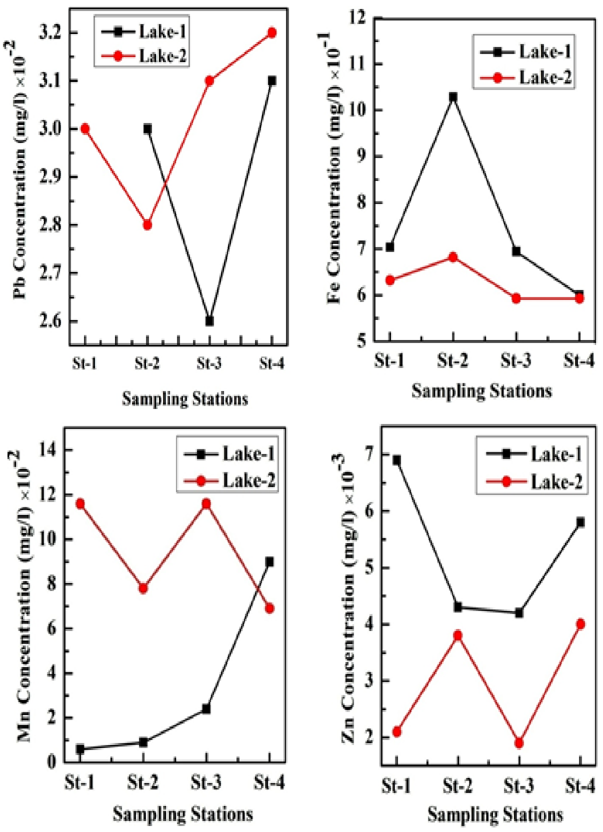

Figure 4. Variation of (a) Pb (b) Fe (c) Mn and (d) Zn concentration in different sampling stations.

The highest and lowest concentration was observed in St-4 in Lake-1 and in St-3 in Lake-2 respectively as shown in Figure 4 (a). So it was not harmful during our study period.

Cadmium

Naturally, Cd occurs in ores together with Zn, Pb and Cu. The compounds of Cd are mostly used as several alloys, stabilizers in PVC products, rechargeable Ni-Cd batteries and colour pigment. Metallic Cd is used as an anticorrosion agent (cadmiation). Pollutant Cd in water may arise from mining wastes, industrial discharges and phosphate fertilizers.

The vital health effect of Cd poisoning may causes anaemia, kidney problems and bone marrow disorders. In Japan, the outbreak of cadmium poisoning occurred in the form of itai-itai (ouch ouch) diseases [12]. El-Ebiary et al., observed the high dose of Cd on red tilapia affects the decrease of sperm number. The concentration ranges of Cd in Lake-1 were found below the detection limit as well as Lake-2.

Chromium

The main source of Cr is the printing paper, electroplating and chemical industries [14]. Long term exposure to copper may causes headaches, dizziness, stomachaches, diarrhea and vomiting.

Generally high uptakes of Cr may cause prostate cancer, kidney and liver damage as well as even death. Kolonel, established an association between cadmium exposure and kidney cancer. The concentration ranges of Cr in Lake-1 were found below the detection limit as well as Lake-2.

Copper

The main source of Cu is the petroleum refining, domestic wastes and dyes. The absorption of Cu is necessary because it is a trace element that is essential for human health but too much intake of Cu can still cause eminent health problems like liver and kidney damage and even death [15].

Long term Cu exposure can causes dizziness, headaches, diarrhea and vomiting. The concentration ranges of Cu in Lake-1 were found below the detection limit as well as Lake-2.

Iron

The main source Fe in water may arises from paper industry, power station, pulp and ship yard etc. During our study period the concentration ranges of Fe were found 0.6 to 1.029 mg/l in Lake-1 and 0.593 to 0.682 mg/l in Lake-2 that was higher than the permissible value of WHO but in between the Bangladeshi standard [12].

The highest and lowest concentration of Fe was observed in St-2 in Lake-1 and in St-3 in Lake-2 respectively as shown in Figure 4 (b). So it was harmful during our study period because if anybody inhalates excessive iron oxides, it may cause lung cancer on the otherhand deficiency of iron leads to anemia.

Manganese

The main source of Mn in the atmosphere are natural processes like forest fires, continental dust etc. At low pH, Mn solubility increases in aquatic systems. Human mainly take manganese via water that will be transported through the blood to the kidneys, the pancreas and the liver as well. It can also cause birth defects, skin problems, neurological symptoms, and changes of hair color etc. Mn can cause both deficiency symptoms and toxicity in aquatic lives.

During our study period the concentration ranges of Mn were found 0.006 to 0.024 mg/l in lake 1 and 0.069 to 0.116 mg/l in Lake-2 that was lower than the permissible value of WHO and BBS. So it was not dangerous during our study period. The highest and lowest concentration of Mn was observed in St-1 and St-3 in Lake-2 and in St-1 in Lake-1 respectively as shown in Figure 4 (c).

Zinc

The important sources of Zn are glass, dry cell, textile, and rubber industries etc. In lake system, Zn can be considered to be a contaminating element. If human take too little Zn, they can experience a loss of appetite and skin sores. Most importantly, Zn shortages can even cause birth defects. On the other side, too much intake of of Zn can damage the pancreas and disturb the protein metabolism and cause arteriosclerosi.

In our study period the concentration ranges of Zn were found 0.0042 to 0.0069 mg/l in Lake-1 and 0.0019 to 0.004 mg/l in Lake-2 that was lower than the permissible value of WHO and BBS. So it was not pernicious during our study period. The highest and lowest concentrations were observed in St-1 in Lake-1 and in St-3 in Lake-2 respectively as shown in Figure 4(d).

Pearson correlation analysis

For Lake-1, toxic metals Pb show insignificant positive correlations with Fe and Mn but negative correlations with Zn. Fe show insignificant positive correlations with Pb but negative correlations with Mn and Zn. Mn show insignificant positive correlations with Pb and Zn but negative correlations with Fe.

Zn show insignificant positive correlations with Fe but negative correlations with Pb and Mn. Actually, insignificant correlations was found among the heavy metals in Lake-1. But significant correlation was found for Lake-2.

The concentration ranges of Pb in lake-2 is 0.028 to 0.032 mg/l and show a significant positive correlation ($p<0.05$) with Mn and negative correlation with Fe and Zn as r=-0.971 and -0.115 repectively. The concentration ranges of iron (Fe) in lake-2 is 0.593 to 0.682 mg/l and show a significant positive correlation ($p<0.05$) with Zn and negative correlation Pb and Mn as r =-0.971 and-0.211 repectively.

The concentration ranges of manganese (Mn) in lake-2 is 0.069 to 0.116 mg/l and show a significant positive correlation ($p<0.01$) with Pb and negative correlation with Fe and Zn as r=-0.211 and-0.995 repectively. The concentration ranges of zinc (Zn) in lake-2 is 0.0019 to 0.04 mg/l and show a significant positive correlation ($p<0.01$) with Fe and negative correlation with Pb and Mn as r=-0.115 and-0.995 repectively (Tables 2 and 3).

Table 2. Pearson correlation matrix among toxic metals of the JU lake-1.

Metals	Pb (mg/l)	Fe (mg/l)	Mn (mg/l)	Zn (mg/l)
Pb	1	0.223	0.61	-0.538
Fe	0.223	1	-0.61	-0.503
Mn	0.61	-0.61	1	0.126
Zn	-0.538	-0.503	0.126	1

Table 3. Pearson correlation matrix among toxic metals of the JU lake-2.

Metals	Pb (mg/l)	Fe (mg/l)	Mn (mg/l)	Zn (mg/l)
Pb	1	-0.971*	0.026	-0.115
Fe	-0.971*	1	-0.211	0.304
Mn	0.026	-0.211	1	-0.995**
Zn	-0.115	0.304	-0.995**	1

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

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

Conclusion

In our study, heavy metals in water collected from JU Lake-1 would appear as Fe>Mn>Pb>Cd and from JU Lake-2 would appear as Fe>Mn>Pb>Zn. Basically, insignificant correlation was found among the heavy metals in Lake-1. For Lake-2, toxic metals Pb and Mn show positive correlations among themselves and negative correlations with Fe and Zn. According to PCR at confidence levels of $p<0.01$ and $p<0.05$ suggesting similar source of contamination. Fe was obtained in highest levels in water samples in Lake-1 as well as Lake-2. According to WHO and BBS guidelines, the health problem may occur on exposure to Fe metals only while other heavy metals concentrations are safe. Pb, Mn and Zn were found below the prescribed value of WHO and BBS. Moreover Cd, Cr and Cu have not traced during our study period. In the earth crust, Fe is the most abundant and common trace element. This could be one of the reason for which high concentration of Fe was obtained in water samples of two lakes that would pose a serious problem to the local inhabitants as well as aquatic lives.

Acknowledgments

The authors wish to thank the Atomic Energy Centre, Dhaka, Bangladesh for allowing them to use the laboratory facilities of the Chemistry. This research was financially supported by Department of Physics, Jahangirnagar University, Savar, Dhaka, Bangladesh.

References

1. Beauchemin, James, Hutchins Tiffany L, and Patterson Fiona. "Mindfulness Meditation may Lessen Anxiety, Promote Social Skills, and Improve Academic Performance among Adolescents with Learning Disabilities." *Complement Health Pract Rev* 13 (2008): 34-45.
2. Best, John R. "Effects of Physical Activity on Children's Executive Function: Contributions of Experimental Research on Aerobic Exercise." *Dev Rev* 30 (2010): 331-351.
3. Brunner, Devon, Amitai Abramovitch, and Joseph Etherton. "A Yoga Program for Cognitive Enhancement." *Plos One* 12 (2017): E0182366. Butola,
4. Rachna, and Chauhan Renu. "Effectiveness of Mindful Meditation on Attention, Short Term Memory and Visual Reaction Time on Normal Individual." *Indian J Physiother Occup Ther* 8 (2014): 149-153.
5. Chakrabarty, Jyothi, Vidyasagar M S, Fernandes Donald and Bhat Vinutha, et al. "Effectiveness of Pranayama on The Levels of Serum Protein Thiols and Glutathione in Breast Cancer Patients Undergoing Radiation Therapy: A Randomized Controlled Trial." *Indian J Physiol Pharmacol* 57 (2013): 225-232.
6. Chaya, Mayasandra S, Nagendra Hongasandra, Selvam Sumithra, and Kurpad Anura, et al. "Effect of Yoga on Cognitive Abilities in Schoolchildren from a Socioeconomically Disadvantaged Background: A Randomized Controlled Study." *J Altern Complement Med* 18 (2012): 1161-1167.
7. Gorman, Kathleen S. "Malnutrition and Cognitive Development: Evidence from Experimental/Quasi-Experimental Studies among the Mild-to-Moderately Malnourished. " *J Nutr* 125 (1995): 2239S-2244S.
8. Hillman, Charles H, Pontifex Matthew B, Raine Lauren B, and Castelli Darla M, et al. "The Effect of Acute Treadmill Walking on Cognitive Control and Academic Achievement in Preadolescent Children." *Neuroscience* 159 (2009): 1044-1054.
9. Jayatunge, Ruwan M. "Meditation and Brain Plasticity." (2011).
10. Khalsa, Sat Bir S, Hickey-Schultz Lynn, Cohen Deborah, and Steiner Naomi, et al. "Evaluation of the Mental Health Benefits of Yoga in a Secondary School: A Preliminary Randomized Controlled Trial." *J Behav Health Serv Res* 39 (2012): 80-90.
11. Laude, Monica. "Assessment of Nutritional Status, Cognitive Development, and Mother-Child Interaction in Central American Refugee Children." *Rev Panam Salud Publica* 6 (1999): 164-171.
12. Miller, John J, Fletcher Ken, and Kabat-Zinn Jon. "Three-Year Follow-Up and Clinical Implications of a Mindfulness Meditation-Based Stress Reduction Intervention in the Treatment of Anxiety Disorders." *Gen Hosp Psychiatry* 17 (1995): 192-200.
13. A Ojeka, Stephen, and Ikpefan O Ailemen. "Electronic Commerce, Automation and Online Banking in Nigeria: Challenges and Benefits." *Int J Innovat Digit Econ* 3 (2012): 1-16.
14. Park, Jung Min, Angela R. Fertig, and Paul D. Allison. "Physical and Mental Health, Cognitive Development, and Health Care Use by Housing Status of Low-Income Young Children in 20 American Cities: A Prospective Cohort Study." *Am J Public Health* 101 (2011): S255-S261.
15. Sheela, Hongasandra Rama Rao Nagendra, and Ganpat Tikhe Sham. "Efficacy of Yoga for Sustained Attention in University Students." *Ayu* 34 (2013): 270.

How to cite this article: Nath, Sumon Deb, Tasrina Rabia Choudhury and Rabindra Chandra Sinha. " Investigation of Heavy Metals in Jahangirnagar University Lakes Water in Bangladesh." *J Environ Anal Toxicol* S7 (2021) : 001.