

ASSESSMENT OF ARSENIC, LEAD, MERCURY AND COLIFORM COUNT IN SERDANG LAKE, SELANGOR MALAYSIA

Abdullah Y. Al-Mahdi¹, Mohamed A. Ahmida², Alabed Ali A. Alabed³, Rasheed Abdsalam⁴

¹Microbiology Department and ³Community Medicine Department, Faculty of Medicine Lincoln University College, 47301, Petaling Jaya, Selangor, Malaysia. ²Biotechnology Department, Faculty of Science, Lincoln University College, 47301, Petaling Jaya, Selangor, Malaysia. ⁴Faculty of Dentistry, Lincoln University College, 47301, Petaling Jaya, Selangor, Malaysia.

E. mail: ¹dr.microbiology2017@gmail.com, ²mohamed.ahmed198081@yahoo.com

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ABSTRACT

Environmental impacts from domestic and industrial wastes on aquatic ecosystems have received increasing attention in recent years. Furthermore, water-associated diseases have become one of the ten topmost diseases due to poor drinking water quality. Therefore, this study aimed to determine the concentration of three heavy metals (arsenic (As), lead (Pb), and mercury (Hg)) and coliform count in Sri Serdang Mines Lake. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) was employed for the analysis of heavy metals. Both of fecal coliform (FC) and total coliform (TC) methods were carried out using the membrane filter technique as described by APHA (1995) standard. Results were recorded as colony forming units (CFU)/100 mL of sample. The As, Pb and Hg concentration values were ranged from 0.0287 to 0.0334; 0.0357 to 0.0508 and 0.00058 to 0.00161 mg/L, respectively. The TC and FC of *Escherichia coli* in Sri Serdang Mines Lake were in the range of 10^2 to 10^5 CFU/100 mL. Pb was the most abundant heavy metal present in all the water samples as compared to As and Hg. There were also significant differences ($p < 0.05$) in both TC and FC concentrations in the water samples from all the five stations. Therefore, efficient heavy metal removal and disinfection are essential to prevent possible human exposure.

Keywords: Assessment, Arsenic, Lead, Mercury, Coliform.

INTRODUCTION

Environmental impacts from domestic and industrial wastes on aquatic ecosystems have received increasing attention in recent years (Akl *et al.*, 2018; Jenin Rajasingh *et al.*, 2018). Contaminated discharges and effluents from anthropogenic activities have resulted in severe degradation of many rivers across the globe (Geissen *et al.*, 2015). Similarly, Malaysia is facing a lot of environmental issues regarding water pollution. Rapid development has lessened certain stretches of the lake to the point that it resembles quite a large storm drain in some places contributing to flash floods within Kuala Lumpur, especially following heavy rain (Mokthsim and Salleh, 2014). The pollutants can come from a point source such as industrial waste, while pollutants from non-point sources include agriculture activities and urban runoff. The vast industrialization, urbanization and rapid economic development in Kuala Lumpur have increased the levels of pollution in the lakes and rivers (Nghah and Othman, 2012). Serdang Lake suffers the most since it flows through the state of Selangor. The increase in human population density and the development of industries along the lakes and coastal areas have increased the pollutant inputs and deteriorated the water quality of the surrounding area. In addition, the river flow also influences the water quality of the river system (Lintern *et al.*, 2018; Rostami *et al.*, 2018). The pollution in the various lakes and rivers has necessitated appropriate meas-

ures by water providers toward the provision of a stable tap water supply as well as potable water. Furthermore, suspended solids, *Escherichia coli*, grease, and oil are the main contaminants of lake waters whilst radioactive landfill, solid waste landfills and so on are the major contaminants of groundwater. Land use types correlated with most of the water quality characteristics. Urban lakes are also polluted with sewage treatment plants discharge which overflows due to rainfall and thus leading to fecal contamination which is a major concern in the lake near the town area, where the surface water is used by local residents. Nonetheless, industrial and household wastes which are discharged directly or through leakages in the sewage systems will flow into water sources thus causing excessive pollution of surface and underground water (Selvakumar *et al.*, 2017). Changes in natural quality as well as the distribution of water have devastating ecological impacts. Similarly, the major contaminants of the marine and coastal waters are suspended solids, heavy metals; *E. coli*, oil, and grease.

Water quality is basically a measure of the condition or state of water resources in relation to the requirements of both human needs as well as the biotic species. Water-associated diseases remain one of the leading and top-ten diseases due to poor drinking water quality (Atidégla *et al.*, 2016). Nowadays, the production of biofilm is a major problem in water distribution systems as well as in

domestic water filtration ones. Contamination of supply water predominantly occurs with aerobic, heterotrophic and Gram-negative bacteria like *Pseudomonas aeruginosa* and *E. coli* which can easily reproduce especially in a humid environment and become resistant to the disinfectants thus causing human infections, particularly in the elderly and infants (Adewale *et al.*, 2010; Adewale *et al.*, 2011; Adewale *et al.*, 2012; Haylamichael and Moges, 2012; Ahmed, 2017). Furthermore, a large percentage of the global population has always been denied access to safe water which is supposed to be a basic human right. For instance, the amount of the world's water supply which is available for human consumption is only 0.7% and, unfortunately, this small percentage is also distributed disproportionately. Furthermore, a large population of people living in developing countries has been reported to be suffering from unsafe water-related diseases (WHO, 2014). For instance, about 1.1 billion people (an equivalence of one-sixth of the world's population) were without access to an improved water supply at the beginning of 2000, especially, those living in Asia and Africa. Therefore, this study was designed to determine the concentrations of three heavy metals (arsenic (As), lead (Pb), and mercury (Hg)) and coliform count in Sri Serdang Mines Lake situated in the midst of Serdang town with an approximate length of 3.4 km and width 2.96 km.

Materials and Methods

Heavy Metals Analysis: Inductively Coupled Plasma Mass Spectrometry (ICP- MS) was used for the analysis of As, Pb, and Hg. 50 mL of water sample was filtered with Whatman filter paper (0.45 μm) using the vacuum filtration Kit. The water sample was filtered to prevent any interference in the ICP-MS reading as a result of the presence of suspended material. By using apparatus Optima 8300 ICP-OES Spectrometer which measures the heavy metals concentration in Lake water. The five sampling stations with their latitude and longitude were shown in Table (1).

Samples collection: Water samples were collected from five sample stations as illustrated in Table (1).

Table 1: Stations and sites of water samples correlated to Sri Serdang Mines Lake.

No.	Stations & sites correlated to the lake	Coordinates
St1	North Opposite Mines shopping mall	N 3°02' 33.69 " E 101° 72'04.09 "
St2	East Jalan Anggerik	N 3°02' 38.19 " E 101° 72'28.87 "
St3	South Jalan Melor	N 3°02' 18.91 " E 101° 72'08.91 "

St4	West Jalan Orkid and Heritage Condominium	N 3°02' 35.33 " E 101° 71'81.96 "
St5	Middle Melor lake	N 3°02' 52.26 " E 101° 71'93.06 "

Coliform Bacterial Test: The samples were obtained from the five stations to determine the bacterial count. The sampling process was done two times. The 1st was taken on weekdays and the 2nd was on weekends for comparisons. Both fecal coliform (FC) and total coliform (TC) methods were carried out using the membrane filter technique by APHA (1995) standard. The membrane was carefully placed on the membrane lauryl sulfate (MLS) media culture on a sterile Petri dish. The Petri dish was, then, incubated at 44.0±0.5°C for FC analysis and 37.0±0.5°C for TC. After 24 hours from incubation, colonies with yellow colors were counted. Results were recorded as colony forming units (CFU)/100 mL for each sample as described by Payus and Nandini (2014). MacConkey agar medium was used for the determination of total coliforms in the samples.

Statistical Analysis: All data were collected in triplicates. The analysis was performed using the statistical packages of SPSS version 22. Statistically significant difference analysis was carried out with one-way ANOVA at $p < 0.05$ for each of the parameters among the five sampling stations.

RESULTS

The results of the heavy metals concentrations in all the five sampling stations of Sri Serdang Mines Lake are shown in Figure 1.

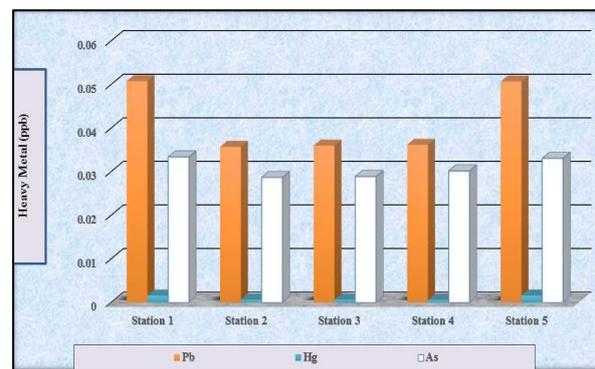


Figure 1: Mean of heavy metals concentration for the five stations.

The As, Pb and Hg concentration values were ranged from 0.0287 to 0.0334; 0.0357 to 0.0508 and 0.00058 to 0.00161 mg/L, respectively. The TC, FC and *E. coli* (Figure 2) in Sri Serdang Mines Lake were in the range of 10² to 10⁵ CFU/ 100 mL. The coliform bacteria group consist of several bacteria genera belonging to the Enterobacteria-

ceae family such as *Enterobacter*, *Escherichia*, *Shigella*, *Salmonella*, *Proteus* and *Klebsiella*. Most bacteria of this group mainly reside in water from the digestive system of human and animals, thus, serving as indicators of polluted water with domestic untreated waste water.

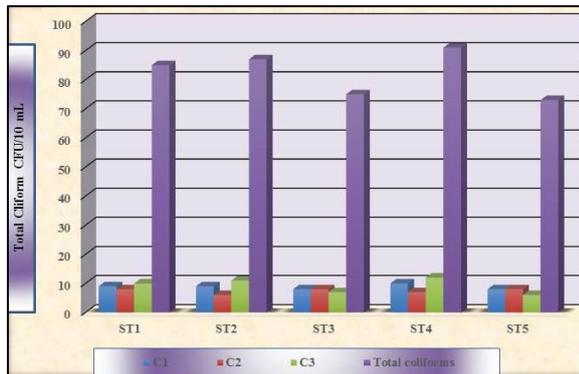


Figure 2: FC on LA medium and LB as a negative control (A), 10^{-2} (B) and diluted 10^{-1} (C).

The range of TC in the lake was from $7 \times 10^2 - 2.5 \times 10^4$ CFU/100 mL. TC for station 1 was 85 CFU/100 mL, station 2 was 87 CFU/100 mL and station 3 was 75 CFU/100 mL, meanwhile station no. 4 showed a higher count of TC with 91 CFU/100 mL and last station showed lowest total coliform 73 CFU/100 mL (Figure 3).

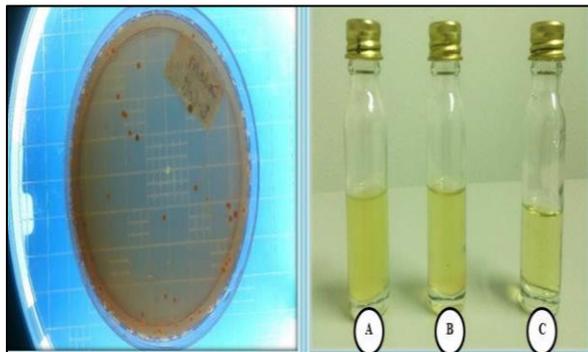


Figure 3: TC and FC of the five stations.

There were significant differences ($p < 0.05$) for TC concentrations in the water sample among the five stations from the one-way ANOVA test. In general, FC bacteria belonging to Enterobacteriaceae family are present in large number in both intestinal tracts and the feces of humans and other warm-blooded animals and can, thus, enter lake water through human and animal wastes. *E. coli* is a Gram-negative short rod, with negative oxidase reactions was chosen as an indicator of fecal pollution (Figure 4). The presence of *E. coli* at all the sampling points is an indication of water contamination by human fecal materials. The number of FC of the lake was varied; some are not detected at 10^3 dilutions at station 3 and 5 and to a maximum value of 3.4×10^3 CFU/100 mL. Most common stations

with a higher count of *E. coli* were at stations 4, 2 and 1.



Figure 4: Gram-negative short rod *E. coli* under a light microscope.

Statistical analysis of coliform which was tested by one-way ANOVA test showed significant differences ($p = 0.02$) for FC concentrations in the water samples from all the five stations.

DISCUSSION

In general, human necessities are responsible for the daily increase in the rate of hydrocarbon pollution (Akl *et al.*, 2018). It is, thus, essential to understanding the causes as well as the ways by which water quality differs within and between river catchments as well as across space for the purpose of effective water quality management (Lintern *et al.*, 2018). Furthermore, both precipitation and flow have been reported to greatly affect water pollution and quality (Rostami *et al.*, 2018). The high concentration of heavy metals observed in this study is primarily owing to the shops, detergents and car wash pollution. Heavy metals found in the urban atmosphere are derived mainly from human activities (detergents, smelting, and car fuel combustion), traffic emissions, and natural sources such as forest fires, minerals, and oceans (Tchounwou *et al.*, 2012). Lead concentrations were higher than As and HG in all the sampling sites. Pb is generally hazardous and toxic to most forms of life especially DNA (Jaishankar *et al.*, 2014; Jan *et al.*, 2015). Hg has a high health effect on all organisms with higher toxicity especially on cell division and genetics (Andreoli and Sprovieri, 2017). Most study stations received untreated human waste discharges from mall, condominiums, restaurants and other human activities. This may be responsible for the high for both the total and fecal bacteria. Our results are in agreement with that reported by Tchounwou *et al.* (2012), Ercumen *et al.* (2017) and Harikumar *et al.* (2017). Diseases which are commonly contacted from high fecal coliform counts water include, but not limited to, dysentery, gastroenteritis, hepatitis, typhoid fever, as well as ear infections (Humphries and Linscott, 2015).

Conclusion

Pb is the most abundant heavy metal present in all water sample as compared to As and Hg. Furthermore, there were significant differences ($p < 0.05$) in both the TC concentrations and FC bacteria in all the water samples from the five stations. Efficient heavy metal removal and disinfection are essential to prevent possible human exposure.

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