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A review on lead (pb) contamination in the drinking water supply at langat river basin, Malaysia

Abstract

Safe water supply at Langat River Basin, Malaysia is very crucial being Langat River the prime source of raw water in the basin. Although several study both river and supply water at the Langat Basin determined higher concentration of dissolved lead (Pb), however, there is no significant study that investigates the Pb concentration in the drinking water supply chain of the basin. Therefore, the review of secondary literature explores the status of dissolved Pb in drinking water supply chain at the Langat Basin in comparison with some other countries. Apart from man-made activities, the higher concentrations of dissolved Pb both in the raw and supply water are mainly from the natural weathering of Pb minerals within the granite rock of Titiwangsa Mountain Range of Langat Basin and the corrosion of galvanized iron pipe, respectively. Therefore, the use of reverse osmosis technology to treat both the raw and supply water at the basin could ensure safe drinking water supply as well as sound health of the populations.

Keywords: water treatment plants, contamination, reverse osmosis, human health

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Introduction

Safe chemical status in the drinking water supply chain (i.e. river, water treatment plant, and household tap) at Langat River Basin, Malaysia (LRBM) is very important because the Langat River provides drinking water to the half of the populations in the state of Selangor, Malaysia.[1,2] Meanwhile, several studies have determined the dissolved Pb (lead) status in the Langat River and in many cases the parameter crossed the raw water quality standard proposed by Ministry of Health Malaysia, United States Environmental Protection Agency and European Commission.[3–5] However, there is no study that investigates the chemical concentrations from upstream to downstream in the Langat River, exactly from where the water treatment plants (WTPs) within the basin take water for the treatment purposes. In the meantime, a few studies at LRBM determined the higher concentrations of Pb[6,7] in the supply water mostly because of its contamination in the water distribution pipeline. Moreover, many studies have considered Pb as an emerging contaminant and its ingestion is an issue of emerging concern.[8–11] However, there is no study which determined the dissolved Pb status in the treated water at the outlets of WTPs as well as the concentration differences between treated water at WTPs and supply water at household level. Thus, the study has reviewed the dissolved Pb status from secondary sources in the drinking water supply chain at Langat River Basin, Malaysia in comparison with some countries around the world. Therefore, the upgrade of water treatment method with the reverse osmosis (RO) membrane technology instead of conventional method at the WTPs of Langat Basin, and the installation of small RO unit at the kitchen's tap of households in the basin will ensure the safe drinking water supply as it is considered as the best available filtration technology by USEPA.[12]

Main body

Dissolved Pb concentration in raw water

The highest observed concentration of dissolved Pb in Langat River was 57.78µg/L,[5] however, similar concentrations of dissolved Pb i.e. 8.7µg/L;[4] 10µg/L[3] and 10±1.56µg/L[13] were also investigated in the Langat River. Moreover, these concentrations of Pb exceeded the stipulated limit of raw water quality i.e. 50µg/L by Ministry of Health Malaysia,[14] the toxic reference value i.e. 2.5µg/L by United States Environmental Protection Agency,[15] and the annual average concentration i.e. 1.3µg/L by European Commission.[16] Similarly, Wang et al.,[17] recorded very high concentration of Pb i.e. 154.96±193.34µg/L in Huaihe River, China, because of both natural and man-made activities. The higher concentration of Pb in the Langat River is mostly from the natural weathering of Pb minerals along the granite rock belt of Titiwangsa Mountain Range. Several studies have also reported the weathering of Pb from the minerals such as Teallite (PbSnS2), Galena (PbS), Franckeite ((PbSn) 6FnSn2Sb2S14) are the important sources of Pb concentration in Langat.[18,19] Apart from the natural weathering process, the use of fertilizers such as arsenal herbicides (i.e. lead arsenate) in the agricultural activities[20] mainly in palm oil plantation[21] as well as tin mining[5,22] are the important sources of Pb in the Langat River. Furthermore, the man-made activities such as electroplating, automobile exhaust, mining, etc. along the river basin also attributes to increase Pb concentration in Langat River.

Dissolved Pb concentration in supply water

So far there is no significant study in Malaysia that reveals the Pb concentration status at the outlets of water treatment plants. However, there are a few studies around the world which determined the Pb concentration in the treated water such as in Saudi Arabia 3.13µg/L,[23] Iraq 6.71±1.16µg/L,[24] etc. might be due to the corrosion of Pb in the galvanized steel pipe. Similarly, the higher dissolved Pb concentration was recorded 32.5µg/L at Bandar Sunway, Langat Basin, Malaysia mainly because of corrosion in plumbing system in the old building.[25] Moreover, the Pb concentration at Bandar Sunway crossed the maximum limit of drinking water quality standard 10µg/L proposed by Ministry of Health Malaysia, World Health Organization, and European Commission, respectively as well as 15µg/L by United States Environmental Protection Agency. However, lower dissolved Pb concentrations were also observed 3.04µg/L at Seri Kembangan et al.,[7] 0.75µg/ Lat Kuala Lumpur[6] and 3±2µg/L in Langat Basin[13] than the concentration at Bandar Sunway within the Langat River Basin.

The higher Pb concentration in the supply water might be primarily from corrosion of the galvanized iron (i.e. zinc coated) pipe[26–28] as well as PVC pipe where Pb used as a stabilizer for manufacturing.[29] Moreover, the combination of copper piping with lead solder at the household level can produce galvanic corrosion to leach lead even in relatively non-corrosive water.[7]

Human health risk of Pb ingestion

Although Greeks and Romans were affected by the excessive lead (Pb) mining but they might not be aware of it.[30] However, recent scientific findings on water supply system indicated that lead (Pb) is the significant contaminant of emerging concern whose toxic exposure occurs through drinking water.[8–10] Meanwhile, Sharrett et al.,[31] and Edwards[32] found that in USA the low concentration of Pb in drinking water in the long run would lead to chronic diseases and fatal deaths as well as Pb contamination in drinking water was not only recorded in urban areas but also in rural areas.

Drinking water treatment

Moreover, all the water treatment plants in Langat Basin follow the conventional water treatment method and the treatment method can remove particle size about 0.5µm,[33] whereas the Pb ions along with other metal ions could be <0.000174µm.[34–36] Contrary, the particulate removal efficiency by reverse osmosis (RO) membrane technology is 0.0001µm.[36] Therefore, USEPA has declared reverse osmosis (RO) membrane technology as the best available technology (BAT) as well as small system compliance technology (SSCT) and it has capacity to remove inorganic ions >90% from treated water.[12] Several studies[37,38] have reported that the lack of stakeholder's participations including government, non-government, private, civil society and public in the Langat River management processes is one of the important reasons of river pollution. Similarly, there is no guideline regarding the discharge of chemicals into environment in the Environment Quality Act 1974 as well as in the amendment of Environmental Quality (Industrial Effluent) Regulations 2009 of Malaysia.[1] However, the European Water Framework Directive (2000/60/EC) reported that the success in improving the aquatic environment relies on close cooperation and coherent action by the stakeholders along proper information and knowledge to them. Similarly, in USA, the Federal Clean Water Act (2002) suggests proper stakeholders' participation for the pollution free aquatic environment.[39] Furber et al.,[40] also urged the stakeholders' participation for the quality improvement of Lake Ontario in Canada through conflict management among the stakeholders. Accordingly, in the under developed African countries such as Kenya, Ghana the stakeholders' participations have been encouraged for the better water resources management through awareness raising and conflict reducing.[41,42]

Conclusion

The natural weathering of Pb mineral along with the man-made activities e.g. agriculture as well as corrosion of galvanized iron pipe might be the prime sources of Pb contamination in the raw and supply water, respectively in the Langat River Basin, Malaysia. Moreover, in many cases the Pb concentrations both in the raw and supply water crossed the stipulated limit of both raw and drinking water quality standards proposed by Ministry of Health Malaysia, United States Environmental Protection Agency, and World Health organization. Therefore, the study of Pb from upstream to downstream in the Langat River will be helpful to determine the pollution sources to reduce the pollution in the river. Moreover, the application of reverse osmosis (RO) membrane technology in the water treatment plants instead of conventional method as well as the installation of small unit of RO at the kitchens' tap in the household level of Langat Basin will ensure the safe drinking water supply.

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Conflict of interest

The author declares no conflict of interest.

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