ORIGINAL ARTICLE

COMPARISON OF HEAVY METAL LEVELS IN NATURAL SPRING AND BOTTLED DRINKING WATER IN KLANG VALLEY, MALAYSIA

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ABSTRACT

A spring is a result of karsts topography where surface water has infiltrated the earth's surface recharge area, becoming part of groundwater and emerges from below to become natural spring water. From few observations, local people tend to consume this water directly for many health reasons. The objective of the study was to determine the concentration of lead (Pb) and cadmium (Cd) in natural water resources and bottled drinking water sources, and compared with the existing standard. This field assessment was carried out in 2014 as part of the educational module for public health master student. About 13 water samples were collected directly from the tubing into the pre-washed sample bottle and rinse with the sampling water in the field. Sample preservation was achieved by acidifying to pH less 4.0 with nitric acid (HNO_3). Samples were stored in a cooler with temperature between 0 to 4°C. Heavy metals were analysed by standard method for graphite furnace atomic absorption spectrophotometer (GFAAS) with Zeeman's correction. Pb and Cd content were analysed from 13 samples which consists of eight natural spring water and five flavoured bottled drinking water. The result showed that Pb content in spring water ranges between 1.8 and 37.3ppb, while the Cd content in spring water ranges between 3.0 and 23.0ppb. In the commercialised drinking water, the amount of Pb ranges between 0.4 and 2.6 ppb, while the content of Cd ranges between 0.8 and 7.0 ppb. This study indicates that there are high content of Pb and Cd in most of the natural spring water points and some bottled drinking water that are available within Klang Valley. In the absence of any specific point sources, the possibility of urban area and high traffic source leading to run off as well as rock types may result in variations observed. Hence, very worrying, especially that these sources of water were consumed directly as drinking water or eye drops without knowing its content. Further tests, coupled with supportive soil and conductivity studies, are required to test all possible similar natural sources to safeguard the health of people.

Keywords: *Pb, Cd, spring natural water, drinking water, Klang Valley*

INTRODUCTION

About 70% of the earth is covered with water, and only about 1% are soft water from lakes, rivers and underground sources. One type of the underground water is spring water. The forcing of the spring to the surface can be the result of a confined aquifer in which the recharge area of the spring water table rests at a higher elevation than that of the outlet.

As the water moves through the underground rocks it will dissolve the minerals and natural metals. This gives the water flavour and even carbon dioxide bubbles, depending on the nature of the geology through which it passes. Iron and tannins often give spring water an orange colour. Other minerals that usually can be found in spring water are magnesium and calcium that dissolved naturally from the rocks[1].

Two particular heavy metals of interested in this study were lead (Pb) and cadmium (Cd). This was due to the abundant presence of the two in Malaysia environment and food chain as mentioned by other studies[2-6]. Both are toxic to the human body as they may affect the kidney system, cardiovascular system, and neurological system lead to various chronic diseases.

In Klang Valley there are multiple locations where it is famous for the local people to collect the spring water and consumed it without doing any form of water treatment. Either they drink the water, they also use it as ear drops or for domestic cleaning. Some of the locations identified in this study are Alam Damai, Sg Long, Sg Tekali, Taman Damai, Bukit Ampang and Ulu Yam. While one hot spring point was taken from Dusun Tua (just for external use, not for drink) and one ground water sample from Sg Gahal.
The objectives of this study were to determine Pb and Cd contents in these natural spring sources and commercialised bottled drinking water, and compare them with the standard.

MATERIALS AND METHODS

Alam Damai spring water sample was taken from an area with coordinate of 3°4'0"N 101°44'22"E. This water source is located along Persiaran Alam Damai near a 30-acre central park. Based on observation, there are housing areas located nearby together with a construction side about 40

meters downhill and 2 km uphill. However, there is abundance of forest reserve surrounding the water sources and no obvious contamination sources noted.

Second sampling was taken from Sungai Long (SILK highway) at coordinates of 3°0'8"N and 101°49'30"E. It is located near to the Saujana Impian exit (Exit16). Downhill to the area is a stone quarry about 5km and other nearest activity was 10km downhill, but none on uphill of the water source. Possible contamination may come from mineral sources as there was a presence of orange-colour tint along the water drainage.

Sungai Tekali spring water sample was taken from 3°6'35.3"N and 101°49'9.6"E location, that is about 8.3 km away from Semenyih Dam Reservoir. Here, there are few small and medium enterprise (SME) industries and housing areas nearby. During the sampling, authors noted the presence of garbages near the intake point. This possible source of contamination was most probably made by visitors who came and eat while waiting to fill their water bottles. Based on an interview with a local folk, who has been consumed the spring water for more than 40 years, claimed that the water quality today was differed from 10 years before.

Taman Damai, Batu 18 Hulu Langat spring water source available at 3°9'46.7"N and 101°50'47.6"E. It is a small town surrounded by forest, near the local police station. The water originated from uphill area. The resident collected the water in a tank that connected with pipe directly to nearby houses. Majority of Taman Damai residences uses both spring and treated water in their daily living activities.

Bukit Ampang spring water was sampled based on the coordinate of 3°7'42"N and 101°47'27"E. It is located near to the Taman Pinggiran Delima exit (B62). Here, there were various human activities nearby, but mainly recreational based. The nearest activity was 5km downhill. On the uphill area there was a sanctuary park present. Possible contamination may occur from animal excreta if activity is not properly managed and taken care of. During sampling, water source was not taken for consumption instead it as used for cleaning purposes as there were people took the water to wash car.

Ulu Yam spring water sample was taken from 3°36'22"N and 101°69'90"E. There are a hill and a forest reserved area. The only activity presence is a recreational park. It is located along Jalan Sungai Tua, in which is a main alternative road to the northern part of Malaysia. There is neither construction, nor a housing area within 5km radius. Here, although there were 3 adjacent intake points, interestingly special one of them just used for topical eyes remedies.

National Youth Training Institute (IKBN) Dusun Tua, Hulu Langat was the only hot spring water sample taken. It was located at 3°13'69"N and 101°83'46"E. It's located near to the Jalan Langat main road that adjacent to a training institution. It's part of the Langat river basin area. There are houses and construction site about 500 meters uphill to the water source. Due to its location, possible contamination could come from the nearby major road and institutional facility.

The only ground water sampling was taken at Sungai Gahal, Hulu Langat at 3°12'26"N and 101°82'10"E. It's located at the side of the Jalan Langat main road near to a traditional village area. This water source is being used by the village people for the past 15 years and they have never used treated water supply since then. During the sampling the water was even used for preparation of food as the operator was a local hawker.

The study was conducted in 2014 as part of parcel of Environmental And Industrial Occupational Laboratory assignment. A field observation was carried out for water pH and temperature determination in situ. Data were collected using a pH meter, EC 10. The observation included water usage, canopy cover, and level of physical pollution in the surrounding area. Data such as longitude and latitude of sampling sites were determined using web based Global Positioning System mapping.

Water samples were collected in labeled plastic bottles. Bottles used for storage of samples were pre-washed in an acid bath with 10% nitric acid solution, followed by rinsing with de-ionized water, to minimize adsorption to bottle side wall. A total of 8 stations was selected. Samples were collected directly from the tubing into the pre-washed sample bottle and rinse with the sampling water in the field. Sample preservation was achieved by acidifying to pH less 4.0 with nitric acid (HNO_3). Samples were placed in a cooler with temperature conditions between 0 to 4°C and transport to a laboratory for analysis. For heavy metal analysis, samples were analysed by standard method for graphite furnace atomic absorption spectrophotometer (GFAAS) [7].

RESULTS

Pb and Cd concentrations were determined from 13 samples which consists of eight spring water points and five flavoured commercialised drinking water (Table 1). The result showed that Pb

concentrations in spring water points were between 1.8 and 37.3 ppb, while Cd concentrations ranged between 8.9 and 23.0 ppb.

Two out of eight spring water points have excessive Pb content than the drinking water standard of 10.0 ppb. The highest risk of Pb toxicity points were included the natural spring of Bukit Ampang and Ulu Yam points that used for cleaning purposes and eye drops respectively. Both points were also identified to contaminated with Cd at a very high concentration. And most of the natural spring water has high Cd content exceeded the drinking water standard of 3.0 ppb. None of the natural spring water points selected in the study are safe.

Bottled flavoured commercialised drinking water samples are safer than the natural spring water. The amount of Pb ranges between 0.4 and 2.6 ppb, while the content of Cd ranges between 0.8 and 7.0 ppb. For sugar cane and lychee flavour have a high limit of Cd that exceeded the standard.

Table 1: Sample location and its uses with Lead and Cadmium content compared to the standard for drinking water

No.	Sample	Uses	Lead (ppb)	Cadmium (ppb)
1	Alam Damai	Drinking	4.48	**15.22***
2	Sungai Long	Drinking	1.80	**21.29***
3	Sungai Tekali	Drinking	3.15	**21.50***
4	Taman Damai	Food preparation	8.33	**21.87***
5	Bukit Ampang	Cleaning	**37.34***	**23.00***
6	Ulu Yam	Eye drop	**21.02***	**22.76***
7	Dusun Tua (HS)	Thermal bath	9.78	**13.31***
8	Sungai Gahal (GW)	Food preparation	4.10	**8.92***
9	Apple	Drinking	0.37	0.92
10	Black-currant	Drinking	2.55	1.85
11	Chrysanthemum tea	Drinking	1.46	0.79
12	Sugar cane	Drinking	2.61	**6.97***
13	Lychee	Drinking	2.48	**6.74***

Source: The study data 2014 (HS: hotspring; GW: groundwater); *exceeded limit

DISCUSSION

Malaysian people are exposing themselves to health risk due to direct consumption of natural spring water points that all were found highly contaminated with heavy metals particularly sad and some of them with Pb. Similar findings were also found in other countries in their spring water[8-10].

Cd was found to be high in all points. Those were samples taken located along the major roadside and almost rock and hilly areas that open to erosion. It may originate from the rocks as the natural type, of heavy metals in the spring water[11-12]. However, card also may present as the result of the road traffic and land status[13-14]. Pb in spring water was also found originated as natural or due to environmental contamination

Both Cd and Pb were found high in spring water points at Bukit Ampang and Ulu Yam. Bukit Ampang spring water was used to wash vehicles that exposed them through skin contact. Even though, Pb is not easily absorbed through the skin, but the exposure was found to be related to skin cancer[15] and other skin disorder[16,17,18]. On the other hand, spring water at Hulu Yam was used as eye drops by passersby or local people. Both heavy metals were identified to be related with corneal oedema and scaring[19,20].

Other spring water points were found to contain high concentration of both metals and not suitable for daily consumption. The pollutions pose elevated risk for microbial contamination[21], various cancers[22,23], and multiple diseases due to cellular oxidative stress effects of both[24].

Regarding bottled drinking water, sugar cane and lychee flavoured were found contaminated with cadmium. Excessive and prolonged consumption of these drinks will also pose many health ailments. Apple, black-currant and chrysanthemum tea flavoured drinking water were content very low level of both metals.

LIMITATION

This study has its limitations in that further supportive tests were not conducted during the water analysis study. We recommend that in the future, soil and sediment analysis, nutrient analysis as well as conductivity testing should be performed concurrently with the water analysis

testing so as to enable a more concrete explanation of the findings.

CONCLUSION

The results of this indicate that there are high levels of lead and cadmium in the natural waters within Klang Valley. These are very worrying, especially that these sources of water are constantly consumed directly almost every day for certain people in the area. Local authority needs to ban the activity until the metal content becomes less than the standard. Further tests, coupled with supportive soil and conductivity studies, are required to reconfirm these findings in the future. High content of metals in certain bottled drinking water granted for closer monitoring by the authority in ensuring the health of the nation.

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