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Assessment of Drinking Water Quality in a Community in Malaysia

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Abstract: Potable water is important for the sustenance and survival of human beings and other living organisms. The present study deals with the evaluation of the drinking water quality in a city of Selangor, Malaysia and to compare the quality of drinking water from various households and restaurants by measuring the various physical and chemical parameters such as dissolved oxygen, biochemical oxygen demand, nitrate, pH, coliform, turbidity and phosphate using the water monitoring kit. All samples showed no abnormal values for dissolved oxygen, biochemical oxygen demand (BOD), turbidity and nitrate**.** The results showed that the contents of total coliform, phosphate and pH exceeded the standard. It was seen that out of 100 drinking water samples, 38 samples had *E. coli* count exceeding the acceptable limit and hence are considered contaminated. 69 samples were collected from houses and 28 samples (40%) out of them were contaminated. Among the 27 samples collected from the restaurants, 10 samples (37%) were contaminated. The results revealed that there was no significant difference in the quality of drinking water collected from houses as compared to the restaurants (P value = 0.56). The pH levels for 99% of the samples were within the acceptable range. 1% of the drinking water samples had phosphate level that slightly exceeded the standards.

Key words: Potable, drinking water, water monitoring kit, indicators, coliform count, pH, phosphate, awareness.

Introduction

Potable water or drinking water has always been an important life sustaining drink to humans and is essential to the survival of all living organisms. There are two main sources of water: surface water and groundwater (Srivastava et al., 2012). Surface water is found in lakes, rivers, and reservoirs. Groundwater lies under the surface of the land, where it travels through and fills openings in the rocks (aquifers). Groundwater must be pumped from an aquifer to the earth's surface for us to use (Wei et al., 2009).

The quality of drinking water is a powerful environmental determinant of health. Safe drinking water is required for the prevention and control of water-borne diseases. The quality of water, whether used for drinking, domestic purposes, food production or recreational purposes has an important impact on health. Contaminated water and poor quality of water can cause disease outbreaks (WHO Water Quality & Health Strategy, 2013). The safety of water does not only support public health, but often promotes socioeconomic development and well-being as well. Drinking water should be free from pathogenic agents and chemical constituents, pleasant to taste and usable for domestic purposes.

Parameters for drinking water quality typically fall under two categories—chemical and physical. Chemical

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parameters causes chronic health risks through build up of heavy metals whereas physical parameters affect the aesthetics and taste of drinking water. The groundwater is characterized by multiple quality problems. Many hazardous pollutants viz., coloured dyes, heavy metals, nitrates and fluoride, agricultural runoffs, waste water treatment plants, combined sewage overflows, storm water discharges, failed septic tanks, prescription drugs etc. pollute it (Srivatstava et al., 2012). Water quality monitoring is defined as the sampling and analysis of water constituents and its conditions which include introduced pollutants, such as pesticides, metals, and oil as well as constituents found naturally in water that can nevertheless be affected by human sources, such as dissolved oxygen, bacteria, and nutrients (USEPA, 2012).

Materials and Methods

The study aims to analyse the quality of drinking water in various sectors of the city of Petaling Jaya, Selangor, Malaysia. The water sources included several dams, lakes and rivers from which the water is treated prior to supply according to standard procedures (WEFWWMC, 2013). There is no available literature on studies about the quality of drinking water in the city of Petaling Jaya (PJ), Selangor. So it was hoped that the potable water available meets the standards as described by the quality parameters set for drinking water and that it is safe for consumption.

Maximum of 100 drinking water samples were collected in sterilized polyethylene or glass bottles (1 litre) from representative houses and restaurants each, which were located in various sectors of the city. The water samples were transported under sterile condition in a cool environment to the microbiology laboratory. Microbiological analysis of water samples was started as soon as possible after collection, to avoid unpredictable changes in the microbial population using the GREEN Low-Cost Water Monitoring Kit. The study attempted to check for physical quality parameters of drinking water namely dissolved oxygen, pH, biochemical Oxygen Demand (BOD), temperature and turbidity; analyse the chemical quality index namely nitrate and phosphate. The study also attempted to check for the presence of coliform bacteria in drinking water and to compare the quality of drinking water obtained from houses against potable water collected from restaurants in PJ. The obtained parameters were compared to the quality control criteria (Malaysian national standards).

Results

A total of 100 samples of drinking water were collected from houses, restaurants and common places located in various parts of the city (Figure 1). Common places include educational institution, hospital and a religious place. The samples were collected to represent the various sectors of the city (Figure 2) based on the population and area.

The samples were tested and analyzed and compared against standard values. The dissolved oxygen, biochemical oxygen demand (BOD), turbidity and nitrate were within normal limits for all the samples (n = 100). A minimal variation in the pH was noted with most samples being in the range of pH 6-8.52.0% samples had a pH of 7, 39.0% were of pH 8 while one sample had pH 9 and eight samples had pH 6 (Figure 3).

A coliform count was done and 47% of the samples were free from coliforms while 38% of the tested samples had coliform count more than 20 cfu/100 ml which is more than the acceptable levels of drinking water standards. 15% of samples had a coliform count less than 20 cfu/100 ml which are within acceptable limits (Figure 4).

The study also revealed that the coliform count did not vary drastically between households and restaurants (p = 0.56) (Table 1).

Discussion

The dissolved oxygen, biochemical oxygen demand, nitrate and turbidity of the drinking water samples collected were within the normal range as per the test standards. Dissolved oxygen is one of the important water quality parameter affecting chemical as well as biological reactions in an ecosystem while biochemical oxygen demand measures the quality of dissolved oxygen used by bacteria as they break down organic matter (USEPA, 2012). The acceptable values are 4 ppm for both dissolved oxygen and biochemical oxygen demand.

Turbidity measures the clarity of the water and how much the material suspended in water decreases the passage of light through the water. Suspended materials include soil particles (clay, silt and sand), algae, plankton, microbes and other substances. Higher turbidity increases water temperatures because suspended particles absorb more heat. This, in turn,

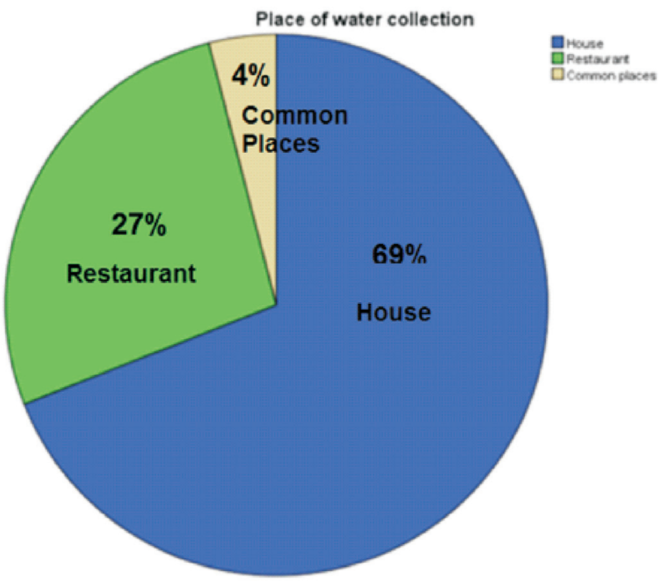

Figure 1: Distribution of households, restaurants and common places from where water samples were collected.

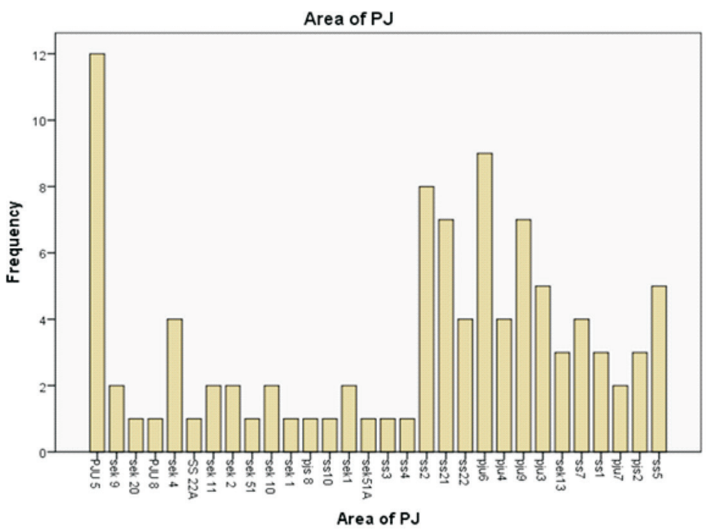

Figure 2: Distribution of sectors from which drinking water samples were collected for analysis.

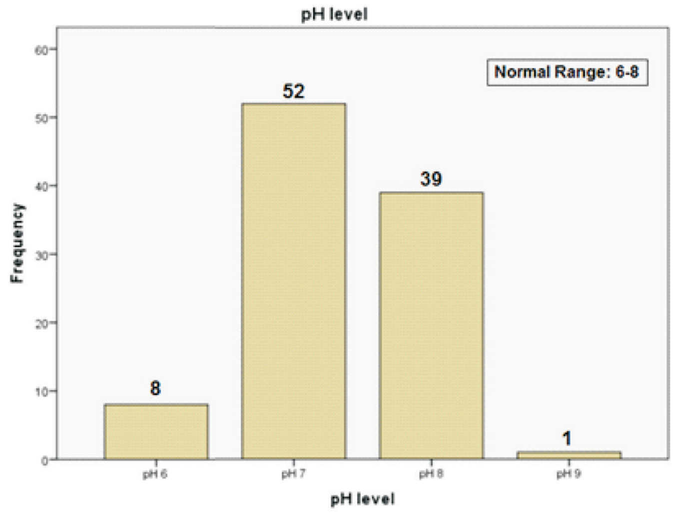

Figure 3: Variation in the pH level amongst the drinking water samples.

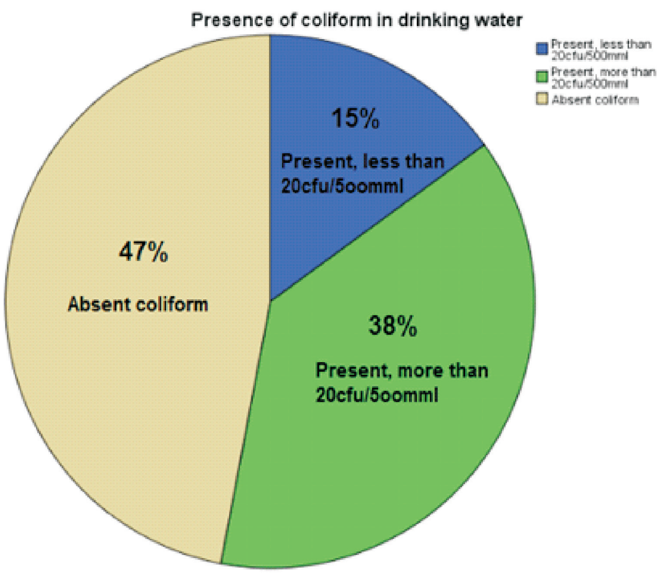

Figure 4: Status of coliform growth in the drinking water samples.

Table 1: Comparison of coliform count among the various types of sources for drinking water

	Present <20 cfu/ml	*Present >20 cfu/ml*	*Absent*	
Houses	9	28	32	$p = 0.56$
Restaurant	5	10	12	
Common places	1	0	3	
Total	15	38	47	

reduces the concentration of dissolved oxygen (DO) because warm water holds less DO than cold. Turbidity can be caused by silt, sand, mud, bacteria, other germs and chemical precipitates (WHO turbidity measurement fact sheet). Nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth. Nitrate contamination of water is due to increasing use of nitrogenous fertilizers and nitrites can cause depletion of dissolved oxygen content of water. The acceptable level for nitrate is 5 ppm.

The normal phosphate level in drinking water sample is <2 ppm. The phosphate value of all the drinking water was less than 2 ppm, except for one which was 2 ppm; collected from a restaurant which used boiled tap water. High phosphate levels can come from man-made sources such as septic systems, fertilizer runoff and improperly treated waste-water. Phosphate is an important nutrient and part of biomolecules in bacterial cells and hence regulates bacterial growth. An increase or decrease in phosphate levels can affect the bacterial growth (Talis et al., 2007).

The normal pH of drinking water samples should be in the range 6-8. The pH of all the drinking water samples was in the range of pH 6 to 8, except for one which was pH 9. The water sample with the pH 9 was collected from a restaurant and the treatment was boiled tap water. Exposure to extreme pH values results in irritation to the eyes, skin and mucous membranes (WHO guidelines on drinking water quality, 2003).

In this study, it was found that major contaminants in drinking water were coliforms. 38% of samples contained more than 20 cfu/500 ml of coliform which indicate fecal contamination. Fecal coliform bacteria are naturally present in the human digestive tract but are rare in unpolluted waters. Common symptoms of water-borne illness include nausea, vomiting, and diarrhea which is more severe in infants, elderly, and those with compromised immune systems. Possible causes of water contamination include improperly treated septic and sewage discharges, uncapped water bottles for a long period, leaching of animal manure, environmental sources, soil and water surrounding pipes, cross connections and backflow (Lee et al., 2002), intrusion and main breaks (Craun, 2001), treatment breakthrough (Fawell et al., 2003), retention time (Gauthier et al., 2001), biofilms and microbial growth. The main causes are biofilm formation in the water distribution system (Lin, 2002) when the sedimentation brings about the colonization of bacteria and water main break that allows contaminants outside the pipe to enter the water distribution system. The control and preventive measures are to keep water at a rolling boil for at least one minute to kill off microorganisms, sanitizing the household and effective treatment methods for microbial contamination which include distillation and permanent point-of-entry disinfection units by using chlorine, ozone and UV light.

Conclusion

This study showed a more than acceptable level of coliform count in samples collected from various sectors of the city. The area had people of various socio-economic background and still revealed coliform presence in almost all sectors (Table 2). This reflects an area of concern in the water piping system which was reported to the water authorities for inspection and rectification. In addition, drinking water at source requires to be further purified (filter system or boiling) before consumption. Water purification and disinfection need to be enhanced, and additional water disinfection facilities should be provided. Water disinfection personnel should be trained regularly, so that they can master water purification skills and disinfection updates. Special attention should be given to the amount of chlorine added into drinking water. High-quality PVC pipes should be used to transport drinking water in water supply networks, and any possible impacts of stress from roads above or from tillage should be avoided.

Table 2: Physical and chemical parameters of drinking water samples collected from different areas

Parameters	*PJU 3*	*PJU 4*	*PJU 5*	*PJU 6*	*PJU 7*	*PJU 8*	*PJU 9*	*Sek 1*	*Sek 2*	*Sek 4*	*Sek 9*	*Sek 10*	*Sek 11*	*Sek 13*	*Sek 20*
Count	5	4	12	9	2	1	7	3	2	4	2	2	2	3	1
Dissolved Oxygen (ppm)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Biochemical Oxygen Demand	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Nitrate (ppm)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Turbidity J.T.U.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphate (ppm)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
pH	6 to 8	7 & 8	6 & 8	7 & 8	7 & 8	6	6 to 8	7 to 8	6 & 7	6 to 8	7	8	7 & 8	6 to 8	8
Coliform	1+, 4–	2+, 2–	3+, 9–	4+, 5–	1+, 1–	1+	4+, 3–	1+, 2–	1+, 1–	2+, 2–	2–	2+	1+, 1–	1+, 2–	1+

Parameters	*Sek 51*	*Sek 51A*	*PJS 2*	*PJS 8*	*SS 1*	*SS 2*	*SS 3*	*SS 4*	*SS 5*	*SS 7*	*SS 10*	*SS 21*	*SS 22*	*SS 22A*
Count	1	1	3	1	3	8	1	1	5	4	1	7	4	1
Dissolved Oxygen (ppm)	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Biochemical Oxygen Demand	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Nitrate (ppm)	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Turbidity J.T.U.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phosphate (ppm)	1	1	1	1	1	2	1	1	1	1	1	1	1	1
pH	7	8	7 & 8	8	7 & 8	7 & 8	7	8	7 & 8	7 & 8	7	6 to 8	7 & 8	8
Coliform	1–	1+	3+	1–	2+, 1–	2+, 8–	1–	1–	1+, 4–	3+, 1–	1–	1+, 6–	4–	1–

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