The Quality of Tap Water of Metropolitan Waterworks Authority

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Abstract

This research is aimed to evaluate the quality of tap water of Bangkok Metropolitan Waters Work in terms of rotaviruses, pH, and free residual chlorine. The study was carried out during July-August of every year from 2006-2010 and 30 samples were collected per year. The tap water samples were collected from households, and government offices. Free residual chlorine, pH, and temperaturewere measured at the sampling points with portable equipment. Five litres of tap water collected in sterilized bottle were carried to the microbiology laboratory, Faculty of Public Health, Mahidol University for rotavirus analysis. The results showed that free residual chlorine was in the ranged 0.20-1.33 mg/l, pH was in the ranged 6.3-7.4, and all samples gave negative result for rotavirus. From the measured free residual chorine, the minimum and maximum values were 0.20-1.33 mg/l, with these concentration of chlorine multiplied by the contacted time (CT) of 30 min give CT factor in the range of 6-39.9 which was much higher than the CT factor of WHO guideline for inactivation of rotaviruses (a). According to WHO guideline for the CT factor and the free residual chlorine for safe quality water supply it should not be less than 0.12 mg/l recommended by World Chlorine Council. Therefore, these results can be ensured that the quality of tap water of MWA is safe.

Keyword : Free residual chlorine, CT factor, rotavirus

Introduction

Water is the most essential part of humans. We require a lot of water for surviving, for daily life activities, and in industrial usages. Water can be polluted by these activities. The most common cause of water pollution is fecal decay; bacteria and viruses enter the water supply through many channels. The viruses of most concern is rotavirus (z). Rotaviruses are transmitted primarily via fecal-oral route, through person-to-person contact. Rotaviruses are the major cause of acute diarrhea throughout the world in infants and young children age < 5 years. According to the WHO, rotaviruses are estimated to be the cause of approximately 527,000 deaths each year, more than 85% of the deaths occurring in low income, developing countries

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(1). Group A rotaviruses are the most common cause of acute gastroenteritis in human (2). Because the virus is stable in the environment, transmission can occur through ingestion of contaminated water or food.

In Thailand, the burden of rotavirus infection rate in children admitted to the hospitals with acute gastroenteritis ranged from 28.4 to 44.5% (3). Rotavirus gastroenteritis in Thailand was detected all year round with the peak from November to April of the following year while in United States the outbreaks are common in the winter and beginning of the spring.

Several unusual strains of human rotaviruses that carried the genes with nucleotide sequences are closely related to those of animal rotaviruses have been reported in Chiang Mai, Thailand (4) which provided evidences for interspecies transmission of rotaviruses between humans and animals are occurring in nature.

In the study of 260 stool samples collected in Thailand from January 2006 till February 2007 from all ages patients with acute diarrhea were tested for group A rotavirus. It was found that 42% of the patients' samples rotavirus were detected. The highest percentage was found in the less than 2 years age group (14%), the second highest rate was found in the children 2-4 years old (5).

Materials and Methods

Virus processing

1. Water samples

Five liters of tap water samples were collected from residential areas and several government offices. All tap water samples were collected in sterile 5 liters bottles and concentrated using a modified adsorption-elution technique previously described (6). Briefly, the tap water was dechlorinated by sodium thiosulfate with final concentration of 50 mg/l. The water samples were adjusted to pH 3.5 with 1 N HCL, and aluminum chloride was added for a final concentration of 0.0015 N to flocculate the virus. Then, the water samples were stirred at room temperature for 30 min and passed through membrane filters with a 0.45 µm pore size (Gelman, Ann Arbor, MI). The membranes were washed with 0.14 M NaCl, pH 3.5 and the viruses were eluted by adding a 2.9% tryptose phosphate broth containing 6% glycine, pH 9.0. The eluates were adjusted pH 7.0 – 7.4 with N HCl and further reduced the volume using a vacuum centriguge (UniEquioLaborgeratebau-und Vertriebs GmbH, Planegg, Germany) to a final volume of 2-5 ml. The water concentrates were stored at -80 ^{o}C until used for nucleic acid extraction.

2. RNA extraction and RT-nested PCR

A 140 µl aliquot of water concentrate was extracted for viral RNA using the QIAamp®Viral RNA extraction kit (QIAGEN GmbH, Hilden, Germany) and 60 µl of the RNA extract were collected.

Rotavirus RNA was detected using the RT-nested PCR previously described (7). The extracted RNA (2 µl) was heated at 94^{o}C for 4 min and placed on ice for at least 10 min. RNA was detected using the SuperScript™ One-Step RT-PCR system with Platinum®*Taq* DNA polymerase (Invitrogen, Life Technologies, Carlsbad, CA). One-Step RT-PCR was performed with a 50 µl reaction volume. The extracted RNA sample (2 µ) was added to the RT-PCR mixture (48 µl) consisting of 1X Reaction Mix (a buffer containing 0.2 mM of each dNTP, 2 mM MgSO4), SuperScript™ III RT/Platinum®*Taq* Mix, 0.25 µM primer RV1, 0.25 µM primer RV2 (8) and nuclease-free water. The RT and PCR were carried out with following steps: RT at 41^{o}C for 60 min; 94^{o}C for 2 min; PCR cycle 1-25 at 94^{o}C for 30 sec, 55^{o}C for 30 sec, 72^{o}C for 60 sec with the final heat at 72^{o}C for 3 min. For nested PCR, 1 µl of the RT-PCR product was further amplified under the same conditions of amplification as for the first PCR, except for changing the primer pair to RV3 and RV4 (3) and their concentrations to 0.5 µM and the concentration of $MgCl_2$ to 3.5mM. PCR products were analyzed by 1.5% agarose gel electrophoresis and ethidium bromide staining. A DNA fragment of 346-bp was considered to be the rotavirus

3.Free chlorine residual, pH and temperature measurements

Free chlorine residual, pH, and temperature were measured in the field at the sampling points with portable equipment: DPD colorimeter, pH meter and thermometer.

Results and Discussion

The tap water samples which were collected from the households and the government offices as shown in Fig 1, the sampling were taken in July and August of year 2006 to year 2010, every sample gave negative result for rotavirus.

The in situ analysis results of pH, free residual chlorine and temperature are presented in Fig. 2, 3, 4 respectively. The residual chlorine mostly met the WHO standard (0.2-0.5 mg/l (WHO 2011)), most samples were in the range of 0.23-1.43 mg/l except the sample which took in the year 2009 there was ten samples the free residual chlorine were in the range 0.05-0.16 mg/l. The pHs were in the range of 6.2-8.3 (WHO guideline 6.5-8.5). There were 4 samples of pH 6.2, 6.3, 6.4 and 6.4. The temperatures were 27.0 - 34^{o}C.

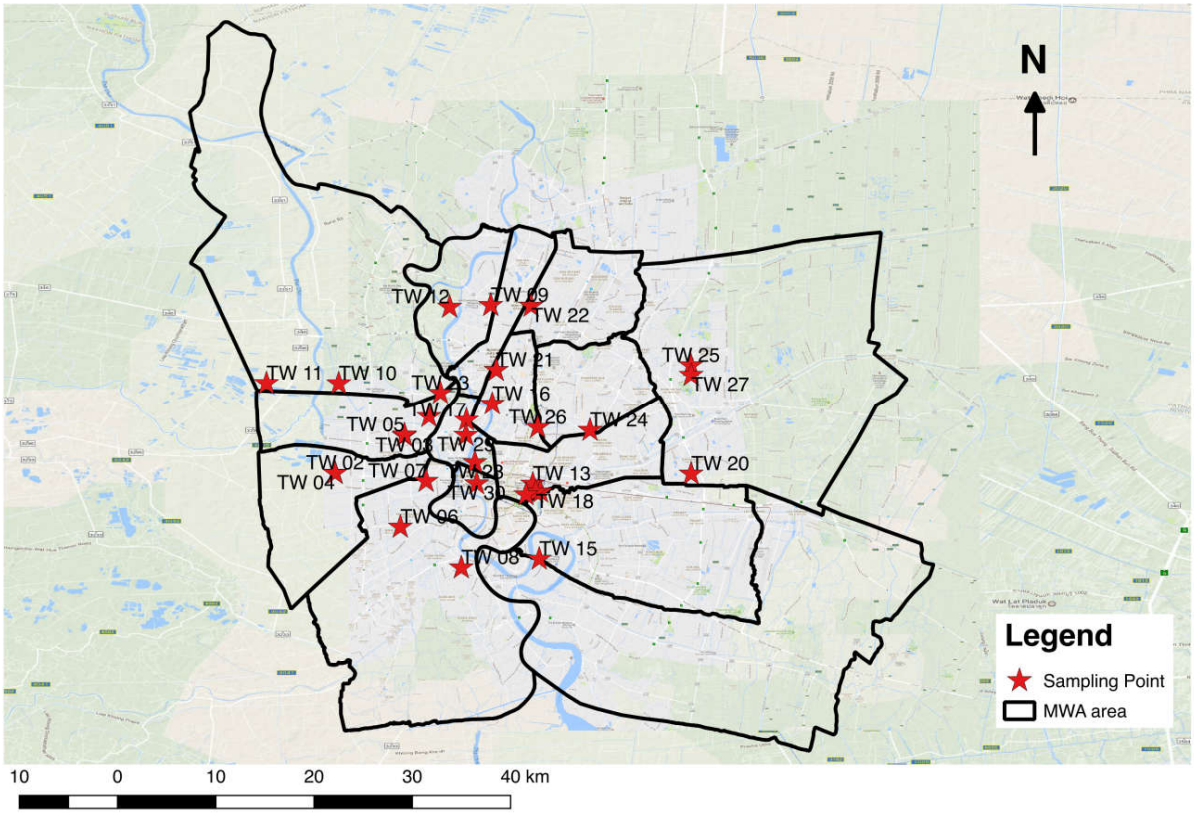
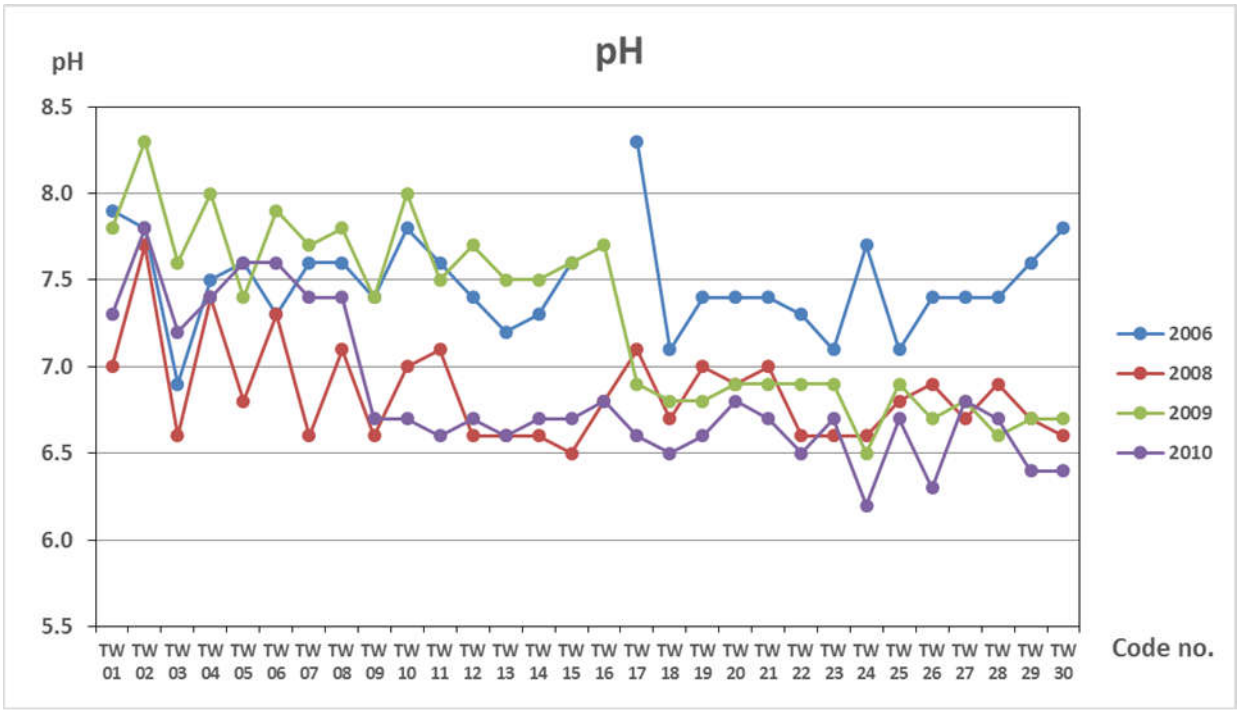


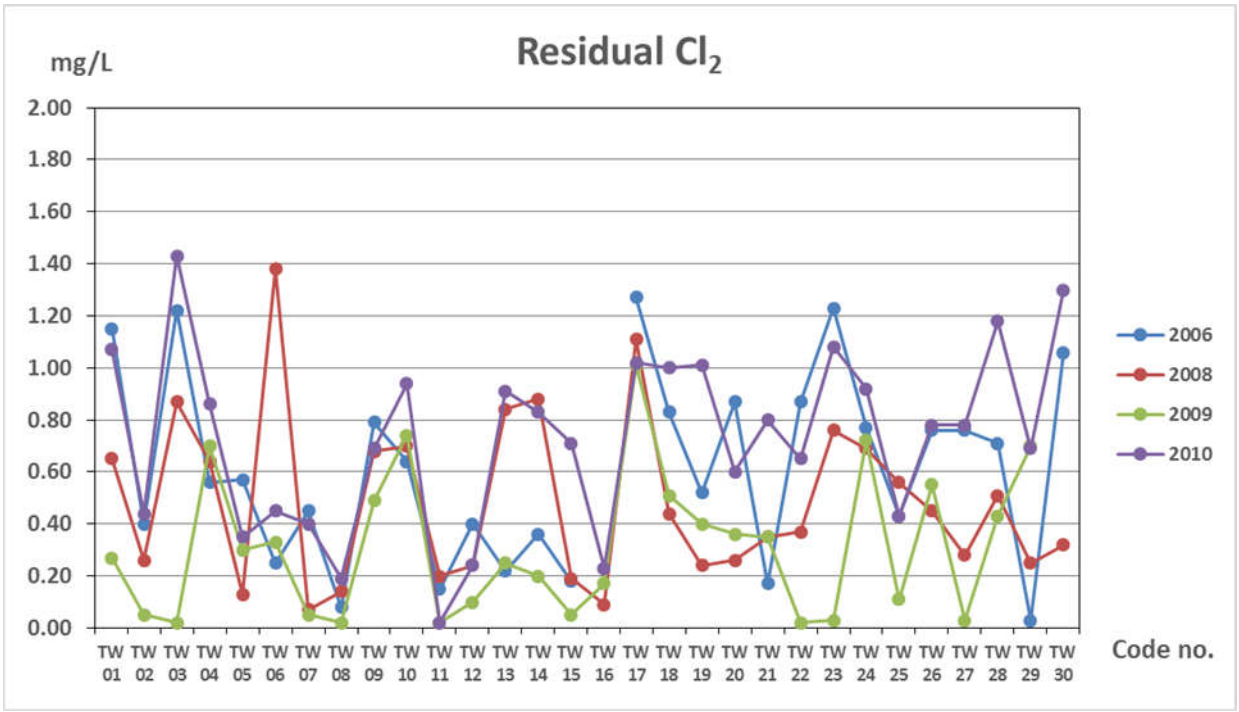
Fig-1 : Tap Water sampling location-Bangkok Metropolitan

Table 1 Analysis of Rotavirus (year 2006- 2010)

No.	Code no.	Year			
		2006	2008	2009	2010
1	TW 01	Negative	Negative	Negative	Negative
2	TW 02	Negative	Negative	Negative	Negative
3	TW 03	Negative	Negative	Negative	Negative
4	TW 04	Negative	Negative	Negative	Negative
5	TW 05	Negative	Negative	Negative	Negative
6	TW 06	Negative	Negative	Negative	Negative
7	TW 07	Negative	Negative	Negative	Negative
8	TW 08	Negative	Negative	Negative	Negative
9	TW 09	Negative	Negative	Negative	Negative
10	TW 10	Negative	Negative	Negative	Negative
11	TW 11	Negative	Negative	Negative	Negative

No.	Code no.	Year			
		2006	2008	2009	2010
12	TW 12	Negative	Negative	Negative	Negative
13	TW 13	Negative	Negative	Negative	Negative
14	TW 14	Negative	Negative	Negative	Negative
15	TW 15	Negative	Negative	Negative	Negative
16	TW 16	Negative	Negative	Negative	Negative
17	TW 17	Negative	Negative	Negative	Negative
18	TW 18	Negative	Negative	Negative	Negative
19	TW 19	Negative	Negative	Negative	Negative
20	TW 20	Negative	Negative	Negative	Negative
21	TW 21	Negative	Negative	Negative	Negative
22	TW 22	Negative	Negative	Negative	Negative
23	TW 23	Negative	Negative	Negative	Negative
24	TW 24	Negative	Negative	Negative	Negative
25	TW 25	Negative	Negative	Negative	Negative
26	TW 26	Negative	Negative	Negative	Negative
27	TW 27	Negative	Negative	Negative	Negative
28	TW 28	Negative	Negative	Negative	Negative
29	TW 29	Negative	Negative	Negative	Negative
30	TW 30	Negative	Negative	Negative	Negative


pH
pH
8.5
8.0
7.5
7.0
6.5
6.0
5.5
TW 01 TW 02 TW 03 TW 04 TW 05 TW 06 TW 07 TW 08 TW 09 TW 10 TW 11 TW 12 TW 13 TW 14 TW 15 TW 16 TW 17 TW 18 TW 19 TW 20 TW 21 TW 22 TW 23 TW 24 TW 25 TW 26 TW 27 TW 28 TW 29 TW 30
Code no.
2006
2008
2009
2010


mg/L
Residual Cl_2
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
TW 01 TW 02 TW 03 TW 04 TW 05 TW 06 TW 07 TW 08 TW 09 TW 10 TW 11 TW 12 TW 13 TW 14 TW 15 TW 16 TW 17 TW 18 TW 19 TW 20 TW 21 TW 22 TW 23 TW 24 TW 25 TW 26 TW 27 TW 28 TW 29 TW 30
Code no.
2006
2008
2009
2010

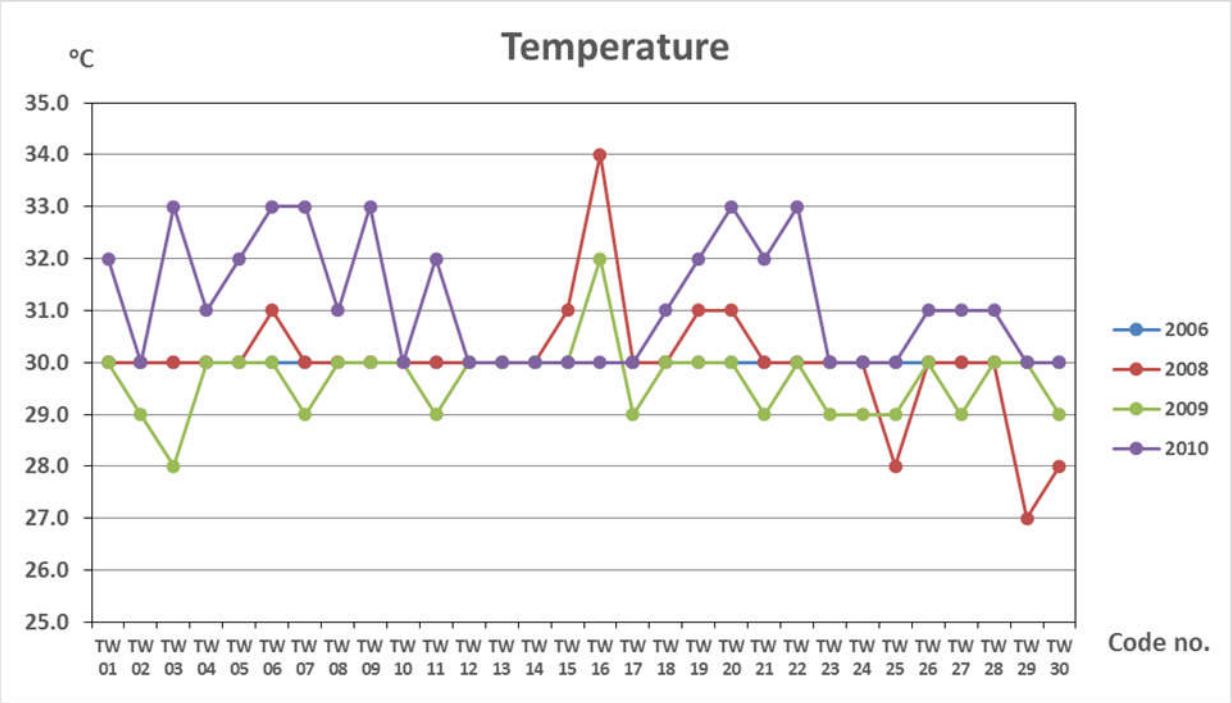


Fig 2. Temperature of tap water from year 2006-2010

From WHO guideline of chlorine in inactivation of rotavirus for chlorine concentration (C) 0.20 mg/l with exposure time(T) 0.25 min CT factor is 0.05 gives efficiency 99.99% (,9,). This study from field measurement of free residual chlorine by average higher than 0.20 mg/l and MWA operating criteria for chlorine contact time is 1 to 1.5 hour this gives the CT factor 12- 18 which is much higher than the CT factor for rotavirus of WHO guideline, so it is 99.99% confidence of rotaviruses free .This can confirmed with the laboratory results of every sample gives negative result.

Conclusion and Recommendation

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From the analyzed data it can be stated that the treatment processes of Bangkok Metropolitan Water Works are functioning properly.

The study, analyzed rotavirus in tap water which had been disinfected by chlorine ,in order to find out the percentage efficiency of chlorine inactivation the presence of rotavirus before and after disinfection process should both be analyzed. This is not only knowing the percentage efficiency of chlorine but also can optimize the chlorine dosage of the plant and also reduce the risk of disinfection byproducts.

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