Relationships between levels of heterotrophic plate count bacteria and endotoxin in point-of-use water treatment systems

Kyong Whan Moon · Young Whan Kim · Jong Ryeul Shon

Dept. of Environmental Health, College of Health Sciences, Korea University, Seoul, 136-703 Korea

Abstract

Endotoxin concentrations were measured from 69 point-of-use(POU) water treatment system(WTS) by using Limulus amebocyte lysate(LAL) assay, and the results were compared to heterotrophic bacterial data. Endotoxin concentrations in all POU WTS water samples and tap waters varied within the range 0.8-79.1EU mL^{-1} and 0.1-3.4EU mL^{-1}, respectively. The correlations between endotoxin concentration and HPC bacteria from the water samples showed not significant(r=0.18).

Introduction

The employment of point-of-use home water devices is well-established in Korea due to an increased awareness of environmental pollution and of the limitations of water treatment processes. However, a large body of experimental data from Korea has shown that the employment of certain types of point-of-use device leads to raised numbers of heterotrophic plate count(HPC) bacteria in drinking water, as a result of the multiplication of these organisms within the device itself. Granular activated carbon (GAC) filters and water storage tanks are considered to be particularly prone to this problem.

Heterotrophic plate count is a non-specific term for measure of growth of viable, naturally occurring bacteria in water. HPC bacteria has been used to evaluate overall finished water quality, maintenance of disinfection residuals, absence of bacterial re-growth and general water treatment effectiveness. It is not uncommon, however, to note a significant increase of HPC bacteria in point-of-use(POU) water treatment system(WTS). Re-growth of bacteria in POU devices, especially activated carbon filter, occurs frequently during periods of non-use. Regulation of HPC bacteria is an emerging issue for drinking water system and there has been a debate that HPC values directly relate to health risk either from epidemiological studies or from correlation with occurrence of waterborne pathogens. Bacteria are classified as either gram-

positive or gram-negative, based on their cell-wall characteristics and uptake of Gram's stain.

Endotoxin can be release during bacterial growth and death. Endotoxin is a term for lipopolysaccharides(LPS) located in outer membrane of gram-negative bacteria.

The biological activity of endotoxin is associated with the lipopolysaccharide (LPS). Toxicity is associated with the lipid component (Lipid A) and immunogenicity is associated with the polysaccharide components. Endotoxin is highly toxic inflammatory agents that activate numerous cellular and humoral mediated systems. Endotoxin is extreamly heat-stable and remains viable after ordinary steam sterilization, normal desiccation, and easily passes through filters. Endotoxin has been suspected to cause gastrotinteritis, bath water fever outbreaks and allergic disorder. An outbreak of bath water fever in Finland was associated with high endotoxin concentrations in tap water(40ng mL^{-1}). But, the standards or guidelines for endotoxin is not established in drinking water.

In this study we were determined endotoxin concentrations and HPC bacteria from the tap water and POU WTS.

Materials and Methods

Water samples were collected in pyrogen free plastic vials at the total of 69 each different POU devices from July 10, 2002 to 5 August 2002. Most of the investigated POU devices were composed of sediment filter, pre-carbon filter, membrane filter and post carbon filter.

Collected samples were diluted stepwise with pyrogen free water. Endotoxin in all samples were measured using the kinetic turbidimetric *Limulus* Amoebocyte Lysate(LAL) method using time of onset protocol. The absorbances(405nm) were measured and the time required for the absorbance to increase 0.200units was recorded. The endotoxin concentrations were calculated from log/log linear regression curves of endotoxin concentration versus reaction time. Three concentrations(0.1-10EU mL^{-1}) of control standard endotoxin(CSE) were used for the determination of the calibration curves.

HPC bacterias in water samples were counted by agar plate method. The plate were incubated for 48h at 37°C and the number of colonies formed were counted to determine viable bacteria.

Results and Discussion

Fig. 1 presents the detected endotoxin concentration ranges and the frequency of water samples passed through the POU WTS. Endotoxin concentrations in all POU WTS water samples and tap waters varied within the range 0.8-79.1EU mL^{-1} and 0.1-3.4EU mL^{-1}, respectively. 44 water samples among the total of 69 POU WTS samples were determined below 10EU mL^{-1}. The endotoxin concentrations of tap water detected lower than the water samples collected from POU devices, which can be explained because the chlorination during the water treatment process oxidize the endotoxin, but activated carbon filters and water

storage tanks act as the habitats of HPC bacteria and increase the amount of them.

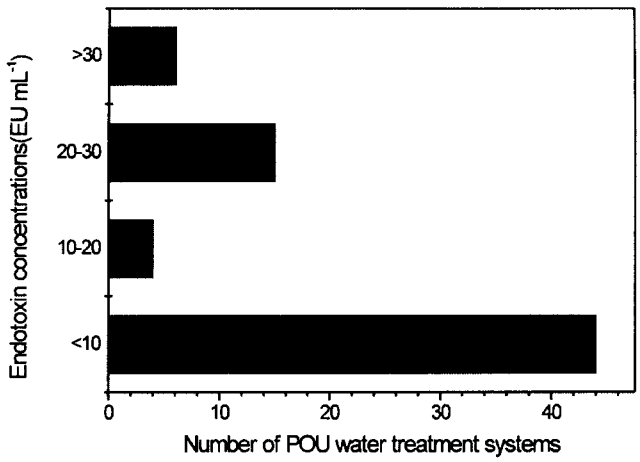

Fig. 1. Frequency of water samples from POU WTS with different range of endotoxin.

Fig.2 presents the endotoxin concentration and HPC bacteria from the water samples. The public health standard for HPC bacteria in drinking water is regulated 100cfu/mL in Korea. 68% water samples among the total of 69 POU WTS exceeded microbial standard. The correlations between endotoxin concentration and HPC bacteria from the water samples showed not significant(r=0.18).

Previously, a limited number of studies have been reported on endotoxin concentrations in drinking water. Endotoxin concentrations of some waterworks in the United States and New England have been reported within the range 0.625-500ng mL^{-1} and 4.6-11ng mL^{-1} from drinking water prior to this study, respectively. Generally, 1EU mL^{-1} corresponds to 0.2ng mL^{-1}. Therefore, these results suggest that endotoxin concentrations is not a level of grave concern so far.

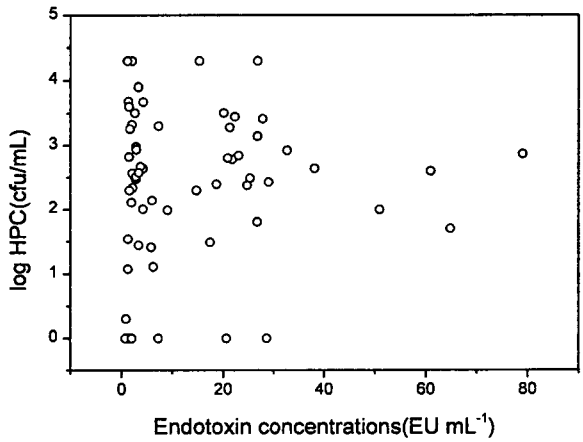

Fig. 2. The relationship between endotoxin concentration and HPC bacteria from the POU water samples

Conclusion

In this study we were determined endotoxin concentrations and HPC bacteria from the tap water and 69 point-of-use(POU) water treatment system(WTS).

Endotoxin concentrations in all POU WTS water samples showed the rage from 0.8 EU mL^{-1} to EU mL^{-1} and tap waters varied within the range 0.1-3.4EU mL^{-1}.

The correlations between endotoxin concentration and HPC bacteria from the water samples showed not significant($r=0.18$).

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