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ORIGINAL ARTICLES

Quality Characterestics of Water Dispensed From Some Public Coolers in Cairo, Egypt

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ABSTRACT

Water coolers are popular in office, buildings, commercial stores and streets. The quality of this source of drinking water has the potential to cause waterborne outbreaks. The aim of this study was to determine the quality of water plumbed in coolers from streets in comparison with main water supply in Cairo and measure the efficiency of water treatment plants in the treatment process of River Nile water to exclude its responsibility in the transmission of diseases. Raw water of River Nile, treatment plants, main water supply and water coolers were collected. For each sample microbiological and chemical indicators of contamination were evaluated in order to determine its compliance with the drinking water WHO guidelines and Egyptian standards. In all water coolers samples chemical parameters did not exceed the reference values of the drinking water guidelines except for free residual chlorine and lead concentrations, as 28.6% of water coolers were containing <0.5 mg/l free residual chlorine, 19.1% were containing lead higher than 0.01 mg/l, Microbiological results showed that 14.3% of cooler samples showed a higher levels of Total Bacterial Counts than WHO guidelines and Egyptian standards meaning that some of coolers is not suitable for its purpose and lead to water and money loss unless adopting appropriate routinely monitoring system in order to prevent or to diminish the chances of contamination of this water source.

Key words: Public cooler, drinking water standard, chemical pollution, biological contamination

Introduction

Management of water quality, control of water pollution and environmental protection are major issues to preserve living conditions for the future. Egypt has been listed among the ten countries that are threatened by want of water by the year 2025 due to the rapidly increasing population and the human conscientiousness in dealing with water. Over the past decade, there has been a markedly increase in the consumption of water derived from different sources in place of tap water for drinking use in many regions of the world. One of these alternative sources is the water from water coolers, which is popular mainly in office buildings, schools and in the streets, It is well known that the quality and safety of the drinking water continues to be an important public health issue (AbdulRahman, I., 2008; Al-Saleh I., 1996), because its contamination has been frequently described as responsible for the transmission of infectious diseases that have caused serious illnesses and associated mortality worldwide (Chaidez, C., 1999; Giorgio Liguori, 2010; Greenberg, E.A.E., 1998). There has been a substantial increase, in recent years, in the use of water coolers and water dispensing machines that provide an adequate supply of chilled water. There are bottle cooler, faucet (tap) pipe fitted cooler and mains supplied stand floor water cooler, the first two types are widely distributed in workplaces and hospitals while the third one is mainly distributed at open streets as a charity especially in high populated areas. In Cairo, public bottle-less water coolers are found everywhere in the streets. The most well-known form of these public water coolers is a standing model (fig.1). It is connected to a building's water supply, for a constant supply of water, and the electricity, to run a refrigeration component to cool the outlet water, and also to the building's waste removal system to discard the excess water.

Drinking water from coolers may cause some public health risks to consumers. Therefore, the objective of this study was to investigate the chemical and microbiological quality parameters of drinking water plumbed in water coolers from some public coolers in order to verify its compliance with the drinking water Egyptian standards (Hrudey, S.E., E.J. Hrudey, 2007) and the WHO guidelines (Jones, A.Q., 2007).

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Fig. 1: Public Bottle-less Water cooler under Study.

Material and Methods

Sampling:

In summer 2010, twenty one public water coolers were selected haphazardly from different districts in Cairo in addition to samples from: River Nile, treatment plants, the mains supplying the coolers and the water coolers. Ninety water samples were collected for physico-chemical and microbiological analyses as follow:

- Group (I) samples: sixty three water samples collected from the twenty one coolers thrice for each one and mean values were obtained for each result.
- Group (II) samples: twenty one water samples collected from the mains supplying the coolers.
- Group (III) samples: three samples from three treatment plants along Cairo.
- Group (IV) samples: three samples from three positions on River Nile along Cairo.

Methods:

All of the analyses were carried out according to the Standard Methods for the Examination of Water and Wastewater (Levesque, B., 1994). The water samples were analyzed for total bacterial count, total coliforms and faecal coliforms. Total bacterial counts were performed on R2A agar plates and incubated at 28°C for 3 to 7 days. Total coliform counts were determined using the membrane filtration method. 100 ml of water sample was filtered using 0.45 mm pore size, 47 mm diameter filter membranes. The membranes were incubated on m-Endo-Les agar at 37°C for 24 h. Faecal coliform counts were performed with m-FC agar plates and also filtered using the membrane filtration method. The microbiological tests were done in triplicate. Physical parameters (Hydrogen ion concentration (pH value) was measured using pH meter (ORION) model 420A, electrical conductivity was measured using EC meter (WTW) Inolab, level 1 and total dissolved solids were determined by evaporating filtered water samples in a weighed dish on a steam bath and then dried in an oven at 103 ºC to a constant weight. The weight of the residue is the total dissolved solids. Chemical characteristics were also measured {anions that were measured by Ion Chromatography (IC, DX-500 chromatography system) and cations and heavy metals were measured by ICP-OES instrument (Inductively Coupled Argon Plasma-Optical Emission Spectroscopy) (Perkin Elmer Optima-3000, USA)}.

Results and Discussion

1. Physico-chemical and microbiological analyses of River Nile and Plants:

Results of River Nile locations and plants showed that treated drinking water is reliable for drinking purposes and all plants distributed water that essentially free of any physic-chemical pollutants and indicator or pathogenic bacteria.

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2. Physico-chemical analyses results of the water coolers samples:

Water samples were collected from the chosen coolers showed that physical and chemical characteristics of water except for free residual chlorine and lead (Pb) concentrations were complying with the Drinking Water Standards set by the Egyptian Ministry of Health (Hrudey, S.E., E.J. Hrudey, 2007) and the WHO drinking water Guidelines (Jones, A.Q., 2007). They were as follows: pH of water samples was found to range from 6.5 to 7.5, which is in accordance with the 6.5 – 8 range. (Hrudey, S.E., E.J. Hrudey, 2007; Marshall, J.K., 2006) Turbidity was found to fluctuate between 0 and 0.82 NTU with a mean of 0.38 ± 0.3 NTU for the 21 coolers. When turbidity exceeds 1 NTU, pathogenic micro-organisms might be encased in the particles, and hence protected from the action of the disinfectant. For this reason, the United States Environmental Protection Agency (USEPA) placed a maximum contaminant level of 0.5 – 1 NTU for public water supplies (Marshall, J.K., 2006), Total dissolved solids, chlorides, sulfates, and nitrates had the averages of 368± 79 mg/l, 87± 18 mg/l, 138±46 mg/l and 0.15±0.05 mg/l respectively for the 21 coolers as well. Free residual chlorine and lead (Pb) concentrations which represented by Fig (2 and 3).

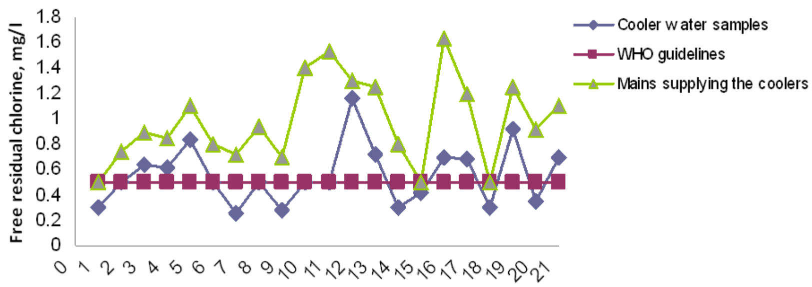

Fig. 2: Free Residual Chlorine of water samples and that of the mains supplying the coolers (mg/l), Compared to who Guidelines.

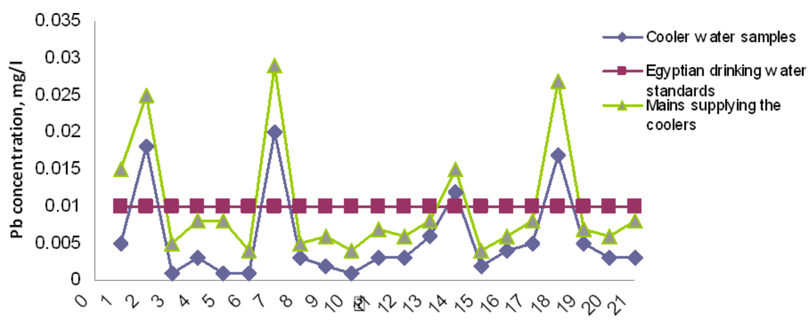

Fig. 3: Lead Concentration of water samples and that of the mains supplying the coolers (mg/l), Compared to Egyptian Standards.

Residual chlorine is not incorporated in the Egyptian Drinking Water Standards, but WHO states that residual concentration of free chlorine should be ≥ 0.5 mg/l (Jones, A.Q., 2007) Drinking water with free residual chlorine indicates that pathogenic organisms have been killed and that water is protected from recontamination.

As shown in figure (2), 15 coolers (71.4% of the coolers under study) were dispensing water with free residual chlorine ≥ 0.5 mg/l. Furthermore, 6 coolers (28.6% were dispensing water with < 0.5 mg/l free residual chlorine. Where samples from the mains supplying the coolers showed that eighteen coolers out of the 21 studied ones were receiving water with residual chlorine ≥ 0.5 mg/l. Residual chlorine in water from the mains was ranging from 0.5 to 1.64 mg/l with a mean of 0.1.007 ± 0.342 mg/l. This indicates the existence of some impurities inside the coolers. These impurities are oxidized by the free residual chlorine which reduces its level below the WHO guidelines. This finding was in agreement with the Centers for Disease Control and Prevention, the Safe Water System (CDCSWS) project that concluded that a free residual chlorine level of 0.5 mg/l will be enough to sustain the quality of water all over the distribution network, but is most likely not sufficient to maintain the quality of water when this water is stored in containers for 24 hours..

Lead concentration (figure 3) showed that 4 coolers (19.1 % of the study sample) were found to dispense water with lead (Pb) concentration higher than the 0.01 mg/l set as maximum allowable concentration by both the Egyptian Ministry of Health and Population (Hrudey, S.E., E.J. Hrudey, 2007), and the WHO Guidelines

(Jones, A.Q., 2007). Lead could be found in the water due to minor corrosion of the houseshould plumbing system and this corrosion might be favored by the low pH range of the cooler water which was found to be 6.7 – 7.

This finding was in accordance with a study carried out in Alexandria, Egypt where samples from water coolers were collected and analyzed for chemical, microbiological and parasitic contamination to assess the water quality of these coolers. The results showed that residual chlorine concentration in 85% of the samples, lead concentration in 65% of the samples, magnesium hardness in 55% of the samples, parasitic contamination and total coliform MPN in 15% of the samples, and thermotolerent coliform as well as Streptococcus fecalis in 5% of the samples (O'Reilly, C.E., 2004). Also, this is in agreement with a study carried out in some schools in Riyadh where water coolers samples were collected and analyzed for some heavy metals. The analysis showed high concentrations of metals that exceeded the World Health Organization (WHO) guidelines (Peace, T., A. Mazumder, 2007). On the other hand, other water samples were collected from several coolers in Riyadh area and analyzed for trace metals. 95.5% of water samples were found to meet World Health Organization (WHO) and Saudi Arabian Standards Organization (SASO) drinking water standards whereas 4.5% were found to have elevated levels of Fe, Pb, and Ni. (Reynolds, K.A., 2007). While, a similar study in Italy showed that all the chemical parameters, in all samples the nitrite, ammonium, and free active chlorine residual did not exceed the reference values of the drinking water regulation (Rim, A., Azza and M.K. Wafaa, 2009).

3. *Microbiological analyses:*

Results of the micro-biological analyses of the water samples are presented in table (2) as well as in figures (4 and 5). As shown in figure (4), 18 (85.7%) water samples were found to comply with Drinking Water Standards as regards Total Bacterial Count (TBC) while 3 samples (14.3%) were exceed the guidelines meaning that these ones are not valid for drinking purpose and it is considered as cost and water wasting. This is according to a study done in Italy which found that large number of non-carbonated and carbonated water sampled from coolers revealed a bacteria count higher than the limits stated for TVC. (Rim, A., Azza and M.K. Wafaa, 2009) Similarly, the total and fecal coliform groups are used to test fecal contamination of drinking water, to indicate whether other potentially harmful organisms are present or not. Results of the study revealed that, 3 (14.3%) samples from 21 coolers were violating the Egyptian Drinking Water Standards (Figure 4) for total coliform and 2 (9.5%) samples for fecal coliform. Total coliform was higher than 2/100 ml which is the maximum allowable limit set by the Egyptian drinking water quality standards. Also, numbers of present bacteria were higher in water coolers than that of its main supply which means the contamination of inside parts of the water coolers. This was in agreement with a study carried out in Canada which reported that 28% of water coolers in workplaces were contaminated by at least one coliform or indicator bacterium and/or at least one pathogenic bacterium, compared to 22% of contaminated tap water samples. The researchers were unable to recognize the main factors responsible for the contamination of water coolers, but suggested that the contamination may be caused by the accumulation of small quantity of microorganisms from tap water or from faucet surface which are concentrated at filters. In the United Kingdom, 44% of 25 water coolers examined contained coliforms and 84% had viable counts of greater than 1000 organisms/ ml at 30 °C.(4) In the United States, bacteriological analyses were performed on 30 water coolers, and reported that coliform bacteria was found in 20% of water samples and Heterotrophic plate count bacteria were found in all samples and 73% had numbers greater than 500 CFU/ ml (World Health Organization, 2008).

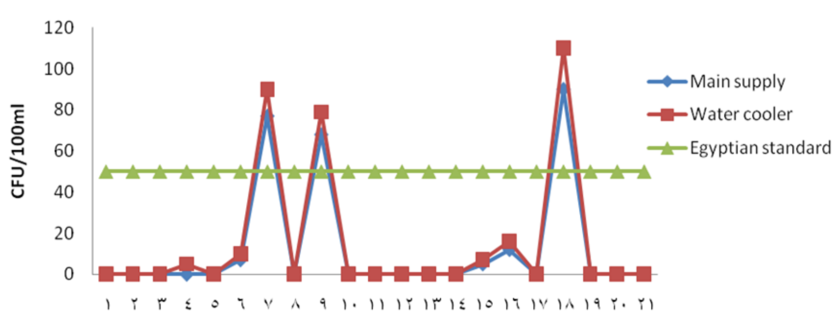

Fig. 4: Results of Total Bacteria Count (CFU/100ml) detected in water samples, Compared Egyptian standards.

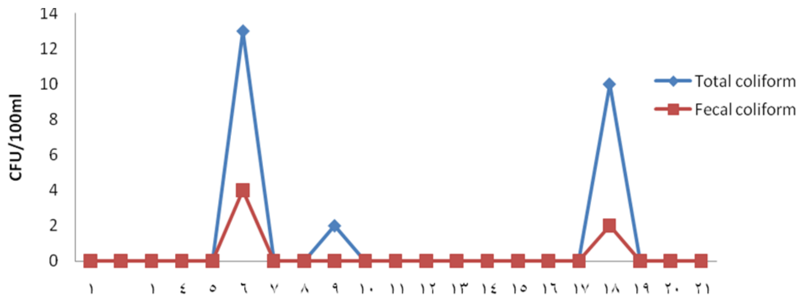

Fig. 5: Results of indicator Bacteria detected water samples, (CFU/100ml).

Conclusion and Recommendations:

Based on the previously discussed results, raise concern about the quality of the drinking water plumbed in water coolers and highlights the importance of adopting appropriate components and monitoring system according to their use and the disinfection of the water in order to prevent or to diminish the chances of contamination of this water source.

Therefore, the study **recommends** the following:

1. Regular maintenance of the cooler, every four weeks using suitable antiseptics for equipment and tools.

2. Internal and external components of the cooler should be exposed to regular maintenance set by the supplier of the cooler.

3. The components of water coolers and the houseshould plumbing system should be made with healthy materials.

4. Maintenance programs should be set by the Ministry of Health at regular intervals for water quality.

5. It is not preferable to install water coolers in areas where they have the potential to become contaminated i.e., nearby toilets, where people with poor personal hygiene can contaminate them.

6. Coolers with a complete system of water purification must be used instead of others.

7. Consumer need more information pertaining water coolers particularly leaving water to run from the cooler for 5 minutes before drinking it, to get rid from bacterial regrowth or lead leaching that might occur inside the cooler during the night.

8. water cooler places must be studied well befor its establishment to avoid contaminated areas and consequently water loss as Egypt threatened by want of water by the year 2025.

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