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# Bacteriological Quality of Water Cooler Dispensers of Educational Settings in Zanjan University of Medical Sciences

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**A R T I C L E I N F O**

**A B S T R A C T**

**Background:** Safe drinking water is one of the main factors in improving health status of the population. The aim of this study was assessment of the microbiological quality, determination of pH and residual chlorine in water coolers' drinking water in educational centers of Zanjan University of medical Sciences in 2015 and comparing the results with the Iranian national standards.

**Methods:** In this cross-sectional study, water samples of all used water cooler apparatuses were sampled and transferred rapidly to the laboratory. pH and residual free chlorine were measured by pH meter and Chlorine Residual Testing kit, respectively. Total coliforms, *Escherichia coli*, Mold and yeasts count were enumerated according to the Iranian national standards No. 1011, 3759, 5271 and 10899-1, respectively. Data were analyzed through the statistical soft wares.

**Results:** The obtained results indicated that 44.44% of the samples were non-standard because of low residual chlorine. 44.44% and 27.8% of the taken water samples of water cooler dispensers were contaminated with mold or yeast and *Escherichia coli*, respectively.

**Conclusion:** According to some microbial contamination in water samples of water cooler devices to ensure availability clean water to consumers (students and hospital's visitors) continuous monitoring, proper maintenance and regular inspection of the water cooler dispensers seems necessary.

## 1. Introduction

Maintenance and promotion of community health is the primary objective of health care authorities. The control of several elements such as water, air, food and environment is required for this purpose. Drinking water is a small fraction of these elements (1, 2).

Poor quality of drinking water is one of the main causes of death worldwide (3). Undesirable water quality throughout the world accounts for 1.7 million deaths annually (1.3% of all deaths in the world). The majority of deaths occur in children (nearly 90 percent) due to diarrhea and gastrointestinal diseases most of which happen in developing countries by ingestion of contaminated water. According to the reports of World Health Organization (WHO), 75 percent of human diseases are due to lack of water sanitation and access to safe water for drinking (4, 5).

Based on WHO definition, the most important features of public drinking water sources are freshness, no turbidity, lack of color and unpleasant smell or taste, and lack of harmful microorganisms and chemical compounds for human health (6).

Aquatic environments are an ideal environment for growth of microorganisms and presence of organic substances in the water is favorable for their growth. Microorganisms as natural inhabitants of water resources are able to grow on surfaces in contact as a biofilm (7). There is a possibility of changing water quality during storage and transport through the distribution network. One of the causes of these changes is biofilm formation as well organized communities of microorganisms and accumulation of pathogenic microorganisms in water distribution networks. Contributing factors of water turbidity such as organic and mineral materials provide suitable conditions for microbial growth and protect the bacteria from adverse environmental conditions such as disinfectants. Connectors, formed sediments in the pipes and blind spots of distribution network are the spreading centers for microorganisms (8, 9).

Despite the advances in science and technology and the efforts made to improve the quality of drinking water, there are still many problems caused by water pollution due to the use of different chemicals, equipment and tools in the refining activities, transmission and distribution of water (10).

There is a sufficient confidence in the absence of microbial contamination in municipal tap water because of residual free chlorine following a strict set of guidelines for drinking water quality, according to national standards on the quality of water intended for human consumption (11).

However, there are potential conditions to uncontrolled secondary contamination when water is transferred from one container to another. Water cooler dispensers are one of these containers. Reduction of water quality and secondary biological and chemical contaminations may occur during transmission and distribution of water. Biofilm formation on the surfaces of water transmission pipes, tanks and household water-treatment apparatuses is one of the remarkable problems and important issues in safe water supply (11).

Water cooler dispensers are devices widely used in summer. Due to their structure and because of stagnating water, there is a desirable condition for the growth of microorganisms and biofilm formation.

Water quality of water coolers depends on environmental conditions, materials, age, maintenance and disinfection services of devices, so water quality will not be similar for all water cooler dispensers (11). Several studies confirmed this issue. In a survey on bacterial quality of water cooler dispensers of Esfahan University of Medical sciences, Heterotroph plate count (HPC) was lower than standard level (<500 cfu/ml) (39).

However, the results of another study on water coolers in Gonabad city showed negative effects of these devices on water quality with an increase in fecal coliforms in water (11).

Regarding the importance of safe drinking water supply for students and staff and necessity of water quality control to prevent any outbreak of water-borne diseases, the aim of this study was to assess the water quality of water cooler dispensers of educational settings (hospitals and Schools) in Zanjan University of Medical Sciences by determining residual free chlorine, pH and microbial quality of water samples.

## 2. Material and Methods

### 2.1. Sampling

Water quality of all available water cooler dispensers of educational settings in Zanjan University of Medical Sciences (schools of health and paramedical, nursing and midwifery, medicine, dentistry, pharmacy and three hospitals (Valiasr, Moosavi and Beheshti) were investigated in a descriptive cross-sectional study. A total of 36

drinking water samples (22 samples of water cooler dispensers and 14 samples of municipal water were collected, over a 3-month period in the summer of 2015 and residual free chlorine, pH and microbiological quality of water samples were evaluated and compared with Iranian national standards. Water samples were collected in sterile dry glass or plastic containers (200 -500 ml).

According to the Iranian national standard No: 2347, samples from the water cooler taps were taken after prior sterilization of the outer surface of the dispenser's faucets with ethanol 95% (12).Then the tap was opened and water flowed for a few moments. Then in sterile conditions, 75% of the container volume was loaded with water .

In addition to water cooler dispensers, municipal water attached to these devices were sampled to compare any probable changes in residual free chlorine and pH. All samples were kept in cold bags at 40 ◦C and transferred to the microbiology laboratory and analyzed within 24 h .

PH and residual free chlorine were measured by pH meter (AZ86505 pH Meter, Taiwan) and Chlorine Residual Testing kit (VAHEB Cl O.T, Iran) according to manual guideline at the time of sample collection.

### 2.2. Bacteriological Analysis

For total bacterial count, the samples were vortexes for 15 s and ten-fold serial dilutions were prepared for each sample. Undiluted and diluted samples were pour plated and spread plated on special mediums by Standard Methods. Total coliforms and *Escherichia coli* were counted using most probable number (MPN) method according to the Iranian national standards No. 1011 and 3759, respectively (13,14). A complementary test was performed on positive tubes to ensure the presence of coliform bacteria. At BGB broth and EC broth mediums were used to confirm total coliform and fecal coliforms. Mold and yeast of samples were enumerated according to the Iranian national standards No. 5271 and 10899-1 (15, 16). HPC was determined using plate count agar (17).

### 2.3. Statistical analysis

Mean and standard deviation (SD) of obtained results were analyzed using statistical software SPSS ver. 20.0. The results are shown as Mean± SD of triplicated experiments.

## 3. Results and Discussion

The results of bacteriological analysis of water coolers and tap water are presented in table 1. Total and contaminated number of water cooler dispensers of educational settings is shown in table 2.The results showed that 63.6% of water samples taken from educational settings had non-standard bacterial contamination according to the Iranian national standard No. 1011 (13). All water samples of attached taps to water coolers were in standard range .

Measured PH value of samples was 7.2 ± 0.2. Residual free chlorine in water samples of Water cooler dispensers and tap water were Zero and 0.2-0.6 ppm, respectively.

PH in all water samples of water coolers was out of standard range and zero (18). HPC of all samples was within standard range except for water samples of Moosavi hospital. In terms of presence of *Escherichia coli*, mold and yeasts and residual free chlorine, 72.2%, 55.6% and 55.6% of taken samples from water coolers were within standard range, respectively and 44.4% of samples did not have residual free chlorine (Fig1).

Residual free chlorine in samples of attached tap water to water coolers and water cooler dispensers were 0-0.6 ppm and zero ppm, respectively. According to the Iranian national standard, residual free chlorine in drinking water should be 0.2-0.8 ppm (18).The obtained results of this study showed that residual free chlorine level of tap waters was at desirable level but after entrance to water coolers declined to zero except samples of one of the settings (Table 1). This result was not in compliance with the obtained results of Mohammadi et al., in which residual free chlorine level before entrance to water coolers (tap water) and after that (water cooler dispenser)

had been 0.4-8.8 ppm and 0.2-0.8 ppm (17) respectively. Reduction of residual free chlorine in the water cooler samples compared to tap water samples show the presence of biological contaminants even in low levels in the water (17).
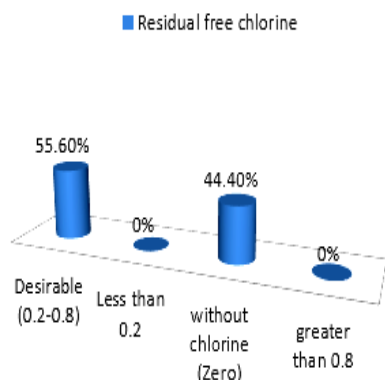


**Fig. 1:** Residual free chlorine in water samples.

PH of the water samples was 7.2 ± 0.2. According to the Iranian national standard pH in drinking water should be within 6.5-9.The results showed that the pH in water samples after storage in water cooler was unchanged and water cooler dispenser had no affected on pH (Table 1).

In this study 72.2 % of samples were negative for total coliforms, which indicate healthy water of water coolers. The main reason for the absence of coliforms may be due to using purified water and primary care of water cooler dispensers (17).

Heterotrophic plate count (HPC) of all water coolers samples except for one of the settings was less than 500 cfu/ml (Table 1). In a similar study Taheri et al. (2010) showed that the number of HPC in the water cooler dispensers was less than standard limit in drinking water (500 cfu/ml) (19). HPC is widely used as an indicator of the quality of drinking water. HPC is considered as a parameter of biofilm formation in water systems (9, 20). High level of HPC can be seen in the plumbing system, home water connections, bottled water and equipment such as water softeners, carbon filters and water coolers (18, 21).

*E. coli* was observed in 27.8% of the samples of water coolers. Presence of *E.coli* is an indication of fecal contamination that may be due to manipulation of dispensers by consumers.

Moreover, mold and yeast were observed in 44.4% of the samples of water coolers. Mold and yeast presence is an indicator of secondary contamination of the water tank of coolers and non-proper cleaning of the water coolers (15).

## 4. Conclusion

PH of drinking water samples of water coolers was at desirable level, but their biological quality was not good. Inadequate attention to water coolers hygiene can cause gastrointestinal diseases especially in the summer when water consumption increases. In addition, residual free chlorine of the water samples was not at desirable level due to water retaining in the water coolers tank and probably the presence of even low amounts of microorganisms. Regarding these results and to ensure availability of clean water to consumers (students and hospital's visitors) continuous monitoring, proper maintenance of the water cooler dispensers, assurance of proper connection to municipal plumbing system and no leakage of the water coolers, continuous sampling of water for the assessment of biological and chemical quality, regular washing and disinfecting of water tanks seem necessary.

## Acknowledgement

**Table 1:** Microbial analysis, pH, residual free chlorine of water samples of water cooler dispenses and municipal water in educational settings of Zanjan University of medical sciences.

| Sampling location | | PH | HPC (cfu/ml) | Total coliforms | E.Coli | Mold & Yeast | Residual free chlorine |
|---|---|---|---|---|---|---|---|
| Valiasr hospital | Water cooler | 7.2 | $20 \pm 7^{*}$ | + | + | - | 0 |
| | Municipal water | 7.1 | 0 | - | - | - | 0.2 |
| Moosavi hospital | Water cooler | 7.3 | $500 \pm 50$ | - | - | + | 0.2-0.4 |
| | Municipal water | 7.2 | 0 | - | - | - | 0.4-0.6 |
| Shafiyeh hospital | Water cooler | 7.4 | 30 | - | - | + | 0 |
| | Municipal water | 7.3 | 0 | - | - | - | 0.2 |
| Beheshti hospital | Water cooler | 7.3 | $19 \pm 11$ | - | - | + | 0 |
| | Municipal water | 7.2 | 0 | - | - | - | 0.2 |
| School of medicine | Water cooler | 7 | 15 | + | + | + | 0 |
| | Municipal water | 7 | 0 | - | - | - | 0.4 |
| Dentistry school | Water cooler | 7.2 | $300 \pm 20$ | + | + | + | 0 |
| | Municipal water | 7.2 | 0 | - | - | - | 0.2 |
| Nursing and Midwifery school | Water cooler | 7.2 | 200 | + | + | + | 0 |
| | Municipal water | 7.2 | 0 | - | - | - | 0.2 |
| School of pharmacy | Water cooler | 7.3 | $27 \pm 5$ | + | + | + | 0 |
| | Municipal water | 7.2 | 0 | - | - | - | 0.2 |
| Health and paramedical faculty | Water cooler | 7.1 | 15 | - | - | + | 0 |
| | Municipal water | 7 | 0 | - | - | - | 0.2 |

**\*** Mean ± SD

**Table 2:** Number of available and contaminated water cooler dispensers.

| Educational units | Total number of Water cooler dispensers | Contaminated Water cooler dispensers |
| --- | --- | --- |
| Valiasr hospital | 4 | No (%) |
| Moosavi hospital | 4 | 2 (50) |
| Shafiyeh hospital | 2 | 2 (50) |
| Beheshti hospital | 2 | 2 (100) |
| School of Medicine | 3 | 2 (100) |
| Dentistry school | 1 | 2(75) |
| Nursing and Midwifery school | 1 | 1 (100) |
| School of Pharmacy | 2 | 1 (100) |
| Health and paramedical school | 1 | 2 (100) |

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