BACTERIOLOGICAL QUALITY OF DRINKING WATER DISPENSED FROM STREETS MAINS SUPPLIED, STAND FLOOR WATER COOLERS

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ABSTRACT

There are about > 500 mains supplied, stand floor water cooler distributed at the streets of Ismailia City region (mainly as a charity). The bacteriological quality of drinking water from five of those water coolers and that of the most –often-used tap water were studied. Samples were analyzed according to tow points of view, one is according the sampling time (month) and the other, is according to the location (site) of the water coolers. T.V.B. mean counts were the lowest (73 &177 cfu/100ml.) in January and May while reaches it's highest in February (6072 cfu/100ml.) with high statistically significant differences ($p \leq 0.01$). *Pseudomonas aeruginosa* was almost absent in September and October but reaches the highest counts in March (1208 cfu/100ml.). But *Aeromonas spp*. showed the highest mean counts in September and October (21cfu/100ml.) while the lowest mean counts were in December, January, February and march respectively with high statistically significant differences ($p \leq 0.01$). Total coliforms (TC) recorded the highest mean counts in December (258 cfu/100ml.) and the lowest in January, September and October respectively with statistical significant differences ($p \leq 0.01$).while feacal coliforms (FC) reaches it's highest mean counts in April and May (7 cfu/100ml.) and considered absent at the other months. *Vibrio spp.* were absolutely absent in all water samples and had no statistical significant differences. Cooler IV showed the highest mean counts of *Aeromonas spp.,* TC and FC (24, 258 &7 cfu/100ml.) except for T.V.B. and *Pseudomonas aeruginosa* counts, which reaches their highest mean counts in cooler V (6072 &1208 cfu/100ml.) with statistical significant differences ($p \leq 0.05$). Cooler III records the lowest mean counts for all the examined bacterial spp. Tap water samples recorded a large counts of *Aeromonas spp*. which was slightly lower than that in cooler IV, and a negligible count of *Pseudomonas aeruginosa* and T.V.B. Cooler IV records the highest counts of (FC) with high statistically significant differences ($p \leq 0.05$). A daily and /or (at least) weekly cleaning should be carried out to the water coolers and dispensers to limit the extent of contamination.

INTRODUCTION

Drinking water allover the world are never described as bacteria-free water. Even though the international organizations, e.g. WHO, that are greatly involved in water quality standards and are seriously concerned about health issues are still confused about how much is too much using terms such as "negligible levels not harmful to health", WHO Guidelines for Drinking Water (1993). The contradictions between chemical disinfectants and bacteriological standards, in one hand and a permissible amount of bacterial pollutants, on the other hand, are also problematic, Gavriel *et al.* 1998, Gauthier *et al.* 1999 and Massa *et al.* 1999. Standards mean permissible counts of bacteria per certain volume of water we are drinking. From the hygiene point of view, this is absolutely unacceptable, unless correlated to the types of these bacteria, their degree of virulence including production of toxins and the user's age, sex, health and immune conditions and the daily average of water intake. This view has been proved by a number of studies such as what Payment *et al.* 1991 did when investigated the possible risk of gastrointestinal disease due to consumption of drinking water meeting current microbiological standards. Schwartz *et al.* 2000 also studied the different response of elderly people in a similar trail. The reported cases of different water-borne diseases, and often epidemics, increased the public awareness about the quality of the water they drink, Araujo *et al* 1989, Höller *et al.* 1998, Buswell *et al.* 1998 and Massa *et al.* 1999, Rusin *et al.* 1997a & b and Schwartz *et al.* 2000. Inefficient treatment regulations and the many problems the treated water face during its journey from the treatment plant to houses via the distribution systems (WHO, 1993). Meanwhile, facts about aquatic bacteria revealed that they can adhere, Servais *et al* 1994, Meinders *et al.* 1995 and Stephano *et al.* 2000, regrow, Servais *et al.* 1991, Mörtel *et al.* 1993 and Kersters *et al.* 1996, dominate, Gavriel *et al.* 1998 and Legnani *et al.* 1998, foul and degrade, Groudeva *et al.* 1987, European Congress 1990 and Groudeva *et al.* 1995. During the passage of water from the treatment works to the consumer, its bacteriological quality may deteriorate (WHO, 1996). Geldreich (1981) reported that once high-quality finished water leaves the water treatment plant and enters the distribution system, some microbial changes would occur. Changes in microbial composition may reflect the presence of organisms surviving in protected habitats within the pipe system. Prevost *et al*. (1997) claim that the role of water suppliers is to provide water of tent quality and to maintain this quality all the way to the customer's tap. This problem becomes even more acute if the water stagnates for a long period of the time in these pipes. the main causal parameter of water being perceived as exhibiting a poor taste is temperature, if drinking water is not cold it will, generally, not taste pleasant or acceptable. 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 tow 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. The analysis of drinking water from some water coolers showed high concentrations of metals and in some cases exceeded the guideline limits recommended by WHO (1996). Moreover water coolers have many problems such as:

1. The location that cooler filling and maintenance takes place. Areas shared with other functions such as pesticide and fertilizer dispensing and/or storage.
2. Ground contact of the cooler tap, lid or filling hose.
3. Touching the tap while dispensing water, the human hand is potentially a bacterial breeding ground. Since there are few, (if any), restrooms with sinks to wash ones' hands, the hand touching the dispensing tap outlet is a very real culprit. Additionally, filling a drinking bottle can transfer saliva from the bottle to the dispensing tap.
4. Animal and insect contact with the dispensing tap.
5. Direct sunlight, wind blown contaminates and sub surface water which will cause bacterial multiplication in standing water.

This study aimed to evaluate the bacteriological quality of drinking water dispensed by streets mains supplied, stand floor water coolers, in Ismailia city region, Egypt.

MATERIALS AND METHODS

Monitoring data: There are about > 500 mains supplied, stand floor water cooler distributed at the streets of Ismailia City region (mainly as a charity). Between December 2004 and October 2005, five water coolers were randomly selected on the basis of their similar sizes and that they are in use (i.e. provide chilled water of about 600 inhabitant/day. Those water coolers are manufactured locally in Egypt from stenless steal metal; the technical data of their component with back view were as in Fig. (1). the specifications and locations of the water coolers under study were as summarized in Table (1). Water samples were collected monthly (WHO,1996) and in the same time from the most- often- used municipal tap water Table (1),there was no attempt to sterilize the outer surface of the taps to make sure that the samples were representative of the water consumed (Levesque *et al,* 1994). 1- Liter water sample were collected in clean sterile glass bottles, containing 1ml of 10% sodium thiosulfate to neutralize free residual chlorine. Samples were immediately analyzed bacteriologically as recorded in Standard Methods for Examination of Water and Wastewater (APHA, 1992). Total viable bacteria (T.V.B) in addition to *vibrio spp*. as well as two indicators of fecal contamination were quantified, total coliforms (TC) and fecal coliforms (FC). *Pseudomonas aeruginosa* (Ps.) and *Aeromonas spp*. (Aero.), which are known to be opportunistic human pathogens, were also quantified.

SAMPLING REGIME

At every sampling time 100 ml from both tap and water coolers were directly filtered on a sterile bacterial filter (MF, ALBET, NCS-0.45 µm- 47 mm diameter- Bc white and graded) using Micro filtration system; (Nalgen Filter Holders). Each membrane from three replicates of these filters with filtered cells was directly placed face up onto Petri dishes containing plate count agar (Oxoid 1985) for (TVB), Endo base agar

(Oxoid 1985) for (TC at 37°C & FC at 44.5°C), T.C.B.S agar medium Scharlau microbiology (2000) for *vibrio sp*., Ampicillin dextrin agar (Havelaar *et al.*, 1987) for *Aeromonas spp*. and *Pseudomonas* selective agar (Oxoid C-N SR 102 E). Incubation at 35°C for 24-48 h followed by enumeration cfu/100ml. Isolates were preliminary identified as they picked up from different culture media, purified, then applied for gram stain, sugar fermentation patterns, oxygen demand, catalase, oxidase, hemolytic activity on blood agar (Buchanan and Gibbons, 1974, Cowan and Steel, 1974, Gruickshank *et al*., 1975, MacFaddin, 1976, Kaper *et al*., 1979). Water and weather temperature was measured using an ordinary thermometer 110°C graduated to 0.5°C for about 5 min. after which the temperature reading was recorded.

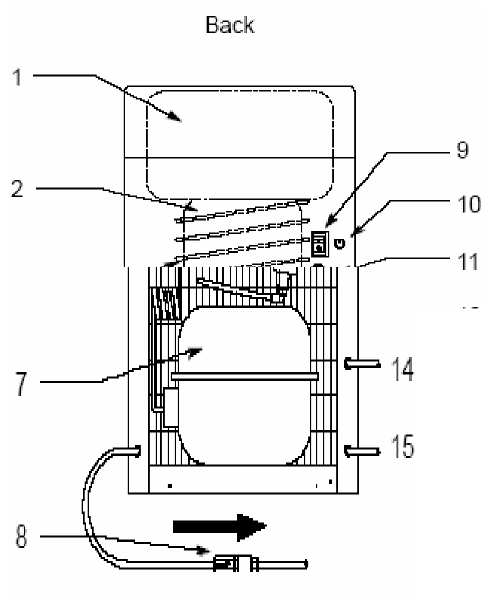

Fig. (1). Schematic representation of the front and back view of streets mains supplied, stand floor water cooler.

1. Water tank
2. Cold water storage
3. Cooling coil
7. Compressor
8. Water drain
9. opearating light
10. Temprature adjaster
11. fuse holder
14. Water inlet conection
15. Mains electric

Table (1):- Specifications of streets mains supplied stand floor water coolers.

Coolers / Specifications	**Dimensions (cm)**	**Temperature of chilled water (°C)**	**Storage tank capacities (gallon)***	**Age of installation (years)**	**Location**
Cooler I	90(w)x60(d)x120(h)	11:14	30	3	Girls hostel of SCU
Cooler II	70(w)x55(d)x120(h)	11:15	20	2	Main gate of SCU campus
Cooler III	70(w)x55(d)x120(h)	12:15	20	2(replaced in April 2005)	Medical center street
Cooler IV	70(w)x55(d)x120(h)	12:15	20	4	Very crowded population main road.
Cooler V	70(w)x55(d)x120(h)	12:15	20	3	

- * Gallon = 3.8 liters
- * Tap: at the Girls Hostel of Suez Canal University (SCU).

RESULTS

The bacteriological quality in the studied water samples were analyzed according to tow points of view, one is according the sampling time (e.g.: different temperature of each month) and as a result the usage of the water cooler, and the other, is the location (site) of the streets mains supplied water coolers. T.V.B. mean counts were the lowest (73 &177 cfu/100ml.) in January and May Fig. (3&7) while reaches it's highest in February (6072 cfu/100ml.) with high statistically significant differences ($p \leq 0.01$), Fig. (4). *Pseudomonas aeruginosa* was almost absent in September and October but reaches the highest counts in March (1208 cfu/100ml.) Figs. (8,9&5). But *Aeromonas spp*. showed the highest mean counts in September and October (21cfu/100ml.) while the lowest mean counts were in December, January, February and march respectively Figs. (2,3,4&5) with high statistically significant differences ($p \leq 0.01$). Total coliforms (TC) recorded the highest mean counts in December (258 cfu/100ml.) where the temperature is (19°C) and the lowest in January Fig. (3), September Fig. (8) and October, Fig. (9), respectively with statistical significant differences ($p \leq 0.01$).while feacal coliforms (FC) reaches it's highest mean counts in April, Fig. (6), and May, Fig. (5), (7 cfu/100ml.) and considered absent at the other months. *Vibrio spp.* were absolutely absent in all water samples and had no statistical significant differences. Cooler IV showed the highest mean counts of *Aeromonas spp.,* TC and FC (24, 258 &7 cfu/100ml.) except for T.V.B. and *Pseudomonas aeruginosa* counts, which reaches their highest mean counts in cooler V (6072 &1208 cfu/100ml.) with statistical significant differences ($p \leq 0.05$). Cooler III records the lowest mean counts for all the examined bacterial spp. Tap water samples recorded a large counts of *Aeromonas spp.* which was slightly lower than that in cooler IV, and a negligible count of *Pseudomonas aeruginosa* and T.V.B. which is a bit higher than in cooler II and III.

The mean counts of *Aeromonas spp*. can be arranged in coolers as followed, cooler II > I > III > V. Cooler IV records the highest counts of (FC) with high statistically significant differences (p≤ 0.05).

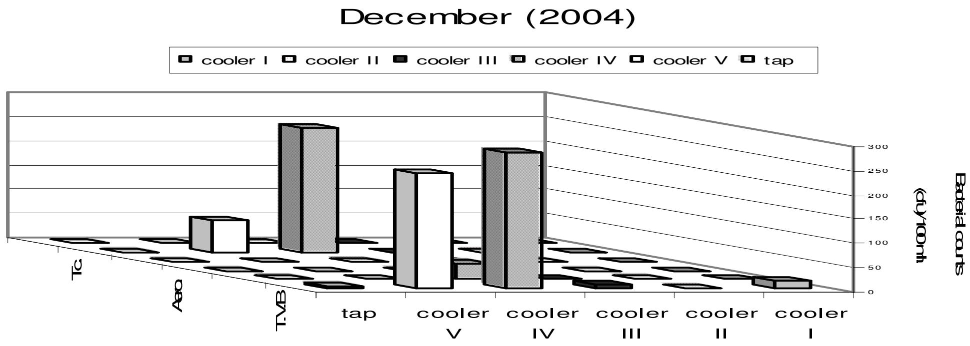

Fig. (2) Total viable bacteria (T.V.B), *Pseudomonas aeruginosa*, *Aeromonas spp*., *Vibrio spp.,* Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap water

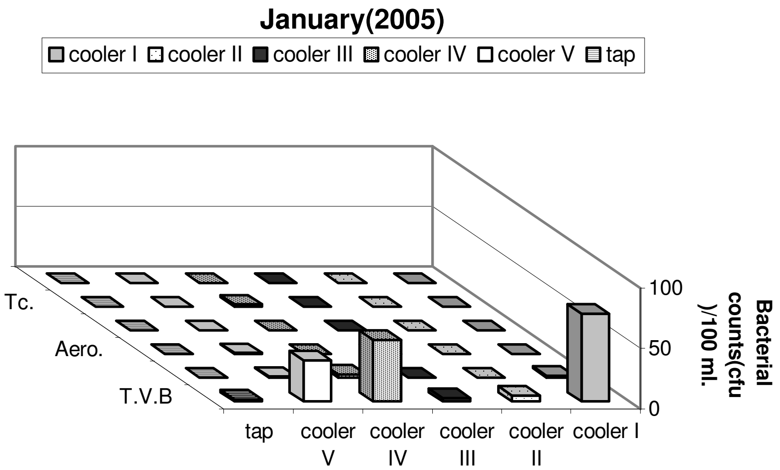

Fig. (3) Total viable bacteria (T.V.B), *Pseudomonas aeruginosa*, *Aeromonas spp*., *Vibrio spp.,* Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap water

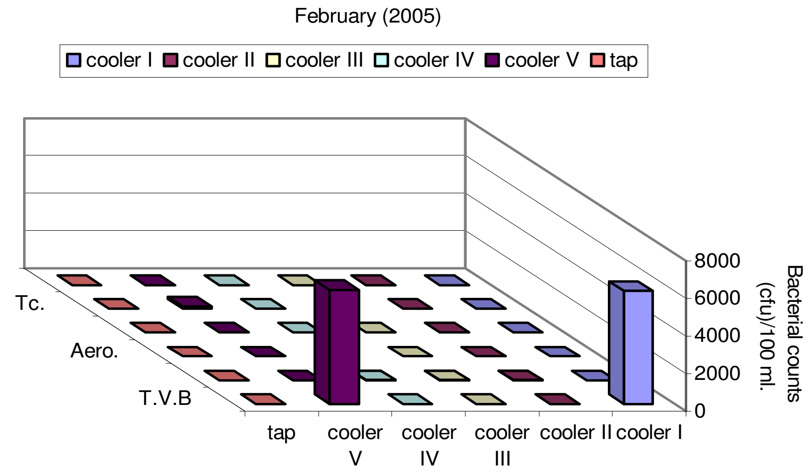

Fig. (4) Total viable bacteria (T.V.B), ***Pseudomonas aeruginosa*****,** ***Aeromonas spp*****.,** ***Vibrio spp.,*** **Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap water**

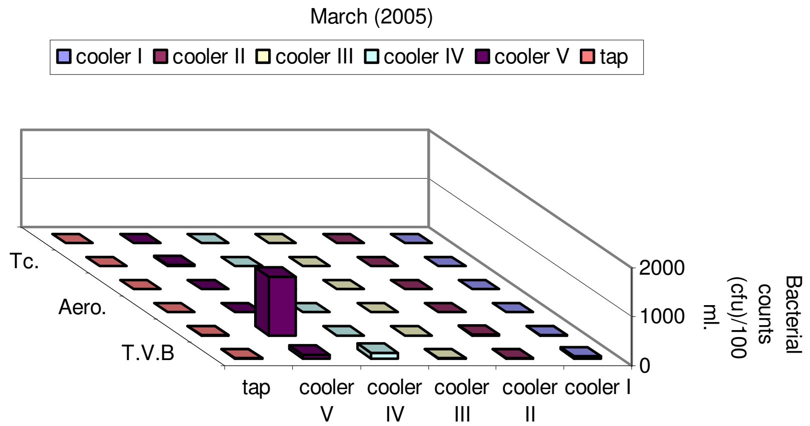

Fig. (5) Total viable bacteria (T.V.B), ***Pseudomonas aeruginosa*****,** ***Aeromonas spp*****.,** ***Vibrio spp.,*** **Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap water**

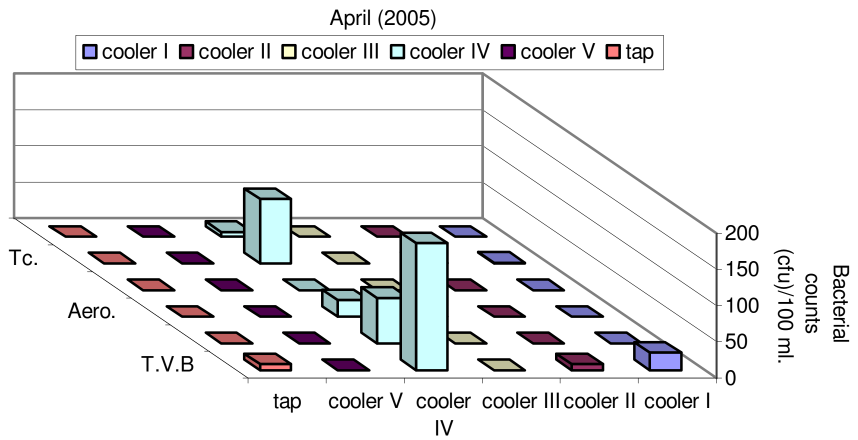

Fig. (6) Total viable bacteria (T.V.B), ***Pseudomonas aeruginosa*****,** ***Aeromonas spp*****.,** ***Vibrio spp.,*** **Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap**

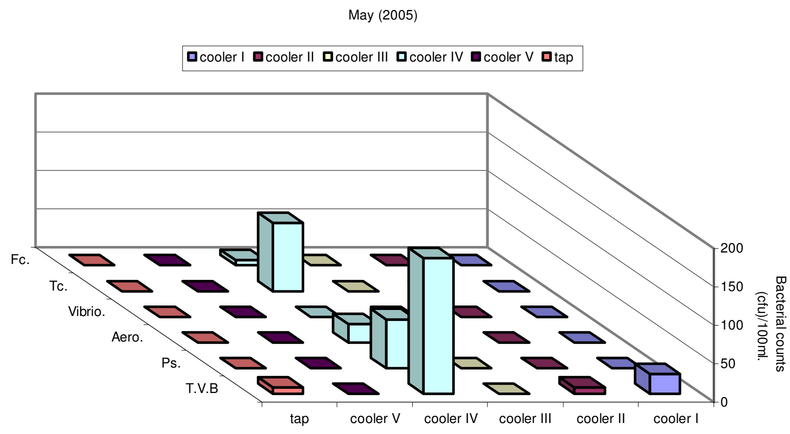

Fig. (7) Total viable bacteria (T.V.B), *Pseudomonas aeruginosa*, *Aeromonas spp*., *Vibrio spp.,* Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap

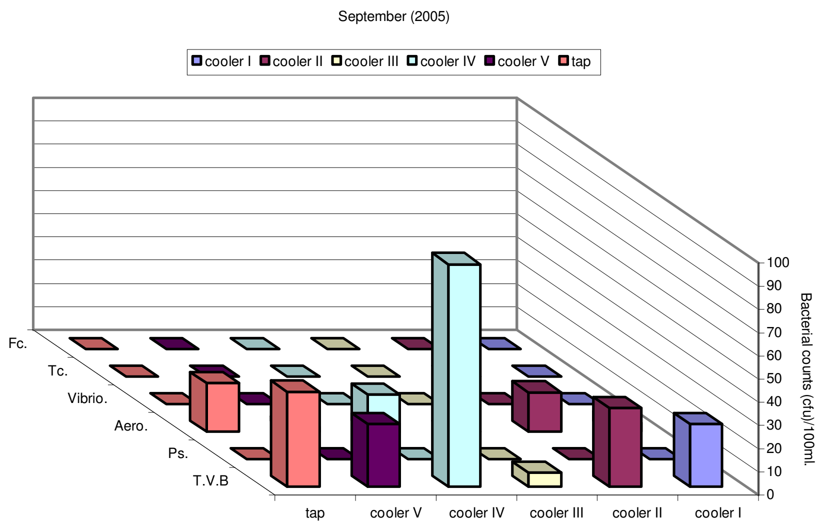

Fig. (8) Total viable bacteria (T.V.B), *Pseudomonas aeruginosa*, *Aeromonas spp*., *Vibrio spp.,* Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap

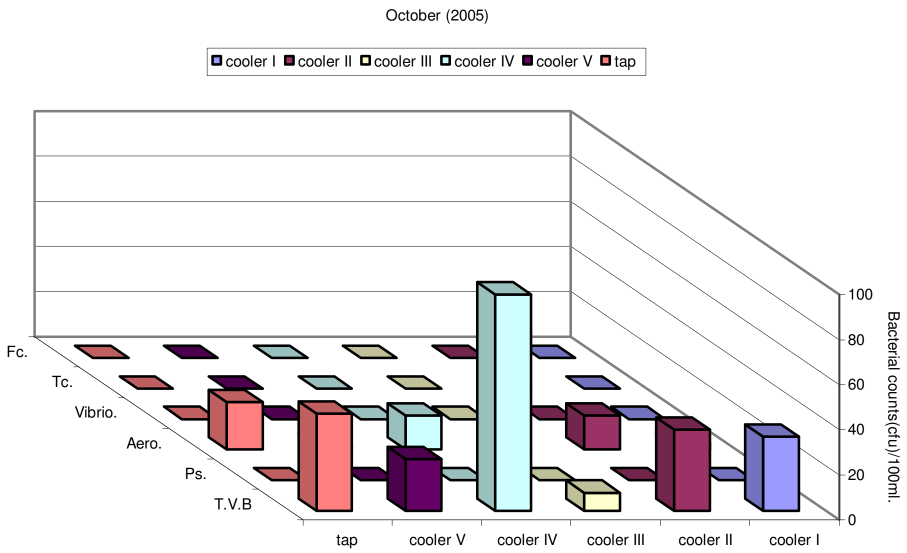

Fig. (9) Total viable bacteria (T.V.B), *Pseudomonas aeruginosa*, *Aeromonas spp*., *Vibrio spp*., Total coliforms (TC) and feacal coliforms (FC) mean counts among the studied water coolers and a municipal tap

DISCUSSION

On the basis of results obtained , the bacteriological quality of municipal tap water is superior to the quality of the water dispensed from streets mains supplied water coolers, there was a statistical significant differences in contamination between the tap water and coolers especially coolers IV&V which are located in a very crowded population main road near by a mosque. Various factors such as socioeconomic status and the presence of very young children as well as the number of persons, were considered, in order to determine if they were related to the water coolers contamination or not. Also the turned off / on pattern of the taps allows the water to stagnate for a long period of time especially during cold weather and holidays. Pointing to the plumping of the connected pipes rather than the municipal water system as a source of contamination (Levesque et al., 1994). Contamination occurs mainly through failure to thoroughly clean the dispensing taps on regular basis and/or as a result of human contact by someone with poor personal hygiene standards (hse.gov.uk.website, 1992). Tap water contamination may be derived from the pluming of the buildings as with lead contamination (AWWA, 1990 and Al-Saleh, 1996). It is probable that the longer the water has been standing in the tap, the greater the potential there is for bacteria to accumulate if there is a source of bacteria in the building's plumbing system. It has been proposed that the tap water should be permitted to flow until it is at a constant cold temperature before use (AWWA, 1990). Identifying the sections of the distribution system in which microbiological degradation is most pronounced also important in order to clarify the legal aspects of the problem, distribution system lines fall under the jurisdiction of the owner and not the utility. With respect to the distribution system, corrective measures could be implemented to improve water quality in the distribution system lines, as in the case of lead and copper control (Prevost *et al.* 1997). Bacterial adhesion can be considered as a thermodynamically reversible process (Meinders *et al.* 1995). Protein films that form on surfaces can profoundly alter the properties and performance of the material onto which they are adsorbed. Microbial adhesion is also affected by the composition of the suspending medium (Stefano *et al.* 2000). Volk and LeChevallier, (1999) showed that bacterial regrowth in distribution systems results from the proliferation and detachment of heterotrophic bacteria from pipe surfaces and conditions that cause the growth of bacteria in distribution systems are complex and site specific. Attachment of bacteria onto pipe surfaces or particles provides disinfection resistance (LeChevallier *et al.* 1988). Even in the presence of chlorine residual coliforms have been observed in drinking water samples (Baylis 1930, Wierenga 1985 and Smith *et al.* 1991).

CONCLUSIONS

The results indicate that we should be cognizant of the quality of the water dispensed from water coolers. Although it is possible to manufacture water coolers and dispensers which are less likely to become contaminated, (Eckner, 1992). Vendors and suppliers of water coolers and dispensers should impress on their client the need for regular maintenance of the equipment. To ensure a high standard of hygiene daily and weekly cleaning should be carried out to the water coolers and dispensers. In addition studies determining the health impact of drinking water from dispensers should be undertaken, and public health authorities should be made aware of water dispenses as a possible source of contamination when investigating water - related epidemics.

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