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Original Article

Bacteriological Quality of Drinking Water Obtained from Mosques in Tripoli, Libya

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ABSTRACT

Objectives: This study was carried out to determine the bacteriological quality of drinking water provided for worshipers by Mosques in Tripoli and the susceptibility of isolated bacteria to antimicrobial agents.

Methods: Water samples taken from 50 mosques were examined for coliform, *Escherichia coli, Enterobacteriaceae, Pseudomonas* sp. and fecal streptococci counts. Also, samples were investigated for the presence of *Aeromonas* sp., *Klebsiella* sp. and *Pseudomonas* sp. Isolated bacteria were tested for their resistance to antibiotics by the disc diffusion method.

Results: Mean counts for coliforms, *E. coli, Enterobacteriaceae* and *Pseudomonas* sp. were 2.2×10^2, 6.2×10^1, 2.5×10^3 and 2.8×10^2 respectively. Fecal streptococci not detected. *E. coli* was detected in 7 (14%) samples, *Klebsiella* sp. in 13 (26%), Aeromonas in 9 (18%) and *Pseudomonas* sp. in 32 (64%). More than 79% of the bacteria examined were resistant to at least one antibiotic.

Conclusion: Presence of antibiotic-resistant pathogenic bacteria is not uncommon in drinking water provided for worshipers by mosques in Tripoli, Libya and may pose a health hazard to users of such water, particularly the aged and the immunocompromised.

Key words:
Water, Bateriological quality, Coliforms, *Aeromonas*, Mosques, Libya.

INTRODUCTION

In the nineties of last century a number of studies on well water used for drinking in Tripoli showed that the bacteriological quality of such water sources is not compliant with the local and World Health Organization standards for drinking water (1,2). The use of contaminated water for drinking may lead to waterborne diseases. Well water is used for other purposes that include bathing, washing clothes, and cooking. In many Muslim countries, well water is also used for wodoo (i.e. washing of hands, mouth, nares, face, arms, hair and feet before praying). Praying in mosques, particularly the Friday prayer is part of Muslims belife. In addition to providing water for wodoo, the mosque authorities are required to provide water for drinking. Most of the mosques in Tripoli have wells and the water from the wells is usually pumped into large metal containers placed on the roofs of the mosques. In the past, water used for drinking in mosques was placed

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in small clay containers that are refilled several times during the day and used directly by worshippers. Nowadays, most of the mosques in Tripoli use stainless steel containers with a tap. Usually one cup is provided with each container and the same cup is used by mosque attendants.

The aims of the present work were to determine the bacteriological quality of drinking water in Tripoli mosques, types of bacteria in such water, and the susceptibility of the isolated bacteria to the commonly used antibiotics.

MATERIALS AND METHODS

***Water samples*:** Samples were taken from 16 small clay containers and from 34 stainless steel containers from 50 mosques in Tripoli. Water samples were collected in sterile glass containers, transported to the laboratory in ice and examined within two hours from collection. The samples were collected between September 2003 and January 2004.

Bacteriology: All samples were examined for coliform and *Escherichia coli* counts by the five tube most probable number technique (3) and for the presence of *Klebsiella* sp., *E. coli* and *Aeromonas* sp. For isolation of *Klebsiella* sp., a loopful from each tube positive for coliforms was plated onto MacConkey agar (MA) and incubated at 37°C overnight. For isolation of *E. coli* a loopful from each tube positive for *E. coli* was plated onto MA and incubated at 37°C overnight. Isolation of Aeromonas was carried out by adding 2.5 ml of water samples to 25 ml of alkaline peptone water (APW, pH 8.5), as an enrichment, and incubated at 37°C. After overnight incubation a loopful from APW was plated onto ampicillin blood agar (ABA, 15mg/L ampicillin) and incubated at 37°C. Suspected colonies from MA and ABA plates were isolated and identified biochemically using standard microbiological procedures (4) and API 20E (bioMerieux, France). Species differentiation of Aeromonas was carried out as reported previously (2). Water samples were also examined for Enterobacteriaceae, *Pseudomonas* sp. and fecal streptococci counts using Food Slide-4 kit (Liofilchem s.r.l., Italy). Isolated bacteria were tested for their resistance to antibiotics by the disc diffusion method (5). Unless otherwise stated, all media and antibiotics discs used in the present work were obtained from Oxoid, UK.

RESULTS

Coliform and *E. coli* counts ranged between <1 - 1.1 x 10^3/ml (mean=2.2 x 10^2/ml) and <1 - 1.5 x 10^2/ml (mean=6.2 x10^1/ml) respectively. Using Food Slide kits *Enterobacteriaceae* and *Pseudomonas* sp. counts ranged between <1 - 1 x 10^4/ml (mean=2.5 x 10^3/ml) and <1 - 1 x 10^4/ml (mean=2.8 x 10^2/ml) respectively. Of water samples examined by the Food Slide Kits, 26 (52%) had *Enterobacteriaceae* counts >10^3/ml. Fecal streptococci were not detected in any sample by the Food Slide kits. *E. coli* was detected in 7 (14%) water samples, *Klebsiella* sp. in 13 (26%), *Aeromonas* in 9 (18%) and *Pseudomonas* sp. in 32 (64%). Pathogenic

Table 1. Pathogenic bacteria isolated from water samples from mosques in Tripoli-Libya.

Bacteria	Clay containers n=16	Stainless steel containers n=34	Total n=50
Escherichia coli	2 (12.5)	5 (14.5)	7 (14.0)
Klebsiella sp.	3 (18.8)	10 (29.0)	13 (26.0)
Aeromonas sp.	2 (12.5)	7 (20.5)	9 (18.0)
Pseudomonas sp.	12 (75.0)	20 (58.8)	32 (64.0)

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Table 2. *Aeromonas* sp. isolated from water samples from mosques in Tripoli-Libya.

Aeromonas sp.	Clay containers n=16	Stainless steel containers n=34	Total n=50
A. hydrophila	1 (6.3)	4 (11.7)	5 (10.0)
A. sobria	1 (6.3)	2 (5.8)	3 (6.0)
A. caviae	0 (0.0)	1 (2.9)	1 (2.0)
Total	2 (12.5)	7 (20.6)	9 (18.0)

Table 3. Resistance to antibiotics of pathogenic bacteria isolated from drinking water from mosques in Tripoli.

Antibiotic	No. (%) resistant			
	E. coli n=7	*Klebsiella sp.* n=13	*Aeromonas sp.* n=9	Total n=29
Ampicillin	2 (29.0)	13 (100)	8 (89)	23 (79.3)
Ceftriaxone	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Ciprofloxacin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Gentamicin	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Tetracycline	1 (14.2)	0 (0.0)	0 (0.0)	1 (3.4)
Trimethoprim- sulphamethoxazole	1 (14.2)	1 (8.0)	2 (22.2)	4 (13.8)

bacteria isolated from water samples in clay and stainless steel containers from mosques in Tripoli are shown in Table 1. Species differentiation of *Aeromonas* is shown in Table 2.

Of the 29 organisms examined, 23 (79.3%), were resistant to ampicillin, 1 (3.4%) to tetracycline, 4 (13.8%) to trimethoprim-sulfamethoxazole and all (100%) were susceptible to ceftriaxone, ciprofloxacin and gentamicin. Resistance profiles of pathogenic bacteria isolated from drinking water in clay and stainless steel containers from mosques in Tripoli to antibiotics are shown in Table 3.

DISCUSSION

There are few reported studies on the contamination with pathogenic bacteria of water used for drinking and other rituals in houses of worship of other religions (6- 8). In a study on the bacteriological quality of water from Thai temples in Songkhia Province, southern Thailand, *E. coli* was isolated from 29% of 76 water samples examined (7). In the present work, we detected *E. coli* in 14% of water samples examined from mosques. This is lower than the rate reported by the Thai study yet, the reported coliform counts of that stady is lower than the present study.

Rees and Allen (1996) examined 13 samples of holy water from a church in UK and reported the isolation of a wide range of bacterial species including *Pseudomonas aeruginosa*, *Enterobacter* sp., *E. coli* and *Aeromonas hydrophila*. *Aeromonas* sp. are new emerging pathogens associated with human disease, especially with diarrhea in children, aged individuals and immunocompromised patients (9- 12). More than 13 species in the genus *Aeromonas*, *A. hydrophila*, *A. sobria* and *A. caviae* are the most common species associated with disease in man (13). In the present study, Aeromonas was detected in 18% of water samples from mosques examined with the predominance

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of *A. hydrophila*. Ghenghesh and coworkers were studying aeromonads in well water in Tripoli and reported similar findings (2).

Pseudomonas sp. are opportunistic pathogens that have been implicated in water- and food-borne diseases (14,15). These organisms were detected in 64% of water samples from mosques in Tripoli. Also, *Enterobacteriaceae* counts >103 were detected in 52% of samples examined. According to the Automatic Vending Association (AVA) of Britain, water samples in containers used with water dispensers with bacterial counts >103/ml are not acceptable to be used for drinking (16).

Most of the isolated bacteria were susceptible to the commonly used antibiotics in Libya. However, resistance to ampicllin was found at 100% for *Klebsiella* sp. and at 89% for *Aeromonas* sp. These findings are in line with those reported previously from Libya (2,17). Ampicillin is an important antimicrobial agent still used for the treatment of a wide range of infectious diseases and in Libya it is still effective in the treatment Shigella-associated diarrhea (18).

In conclusion, presence of antibiotic-resistant pathogenic bacteria is not uncommon in drinking water in mosques in Tripoli-Libya. Our findings show that most of the water samples from different mosques in Tripoli are of unacceptable quality and may pose a health hazard to worshipers. The health and environmental authorities may play an important role in providing guidance and supervision to authorities in charge of mosques to ensure that such quality of drinking water is provided to worshipers. Finally we hope that this study may encourage other investigators from other Islamic and non-Islamic countries to carry out more studies on the bacteriological quality of water used for drinking and other purposes provided by houses of worship of different religions, which in turn may provide a better idea on the quality of such water.

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