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Original Article

Bacteriological quality of drinking water From water vendors in Tripoli-Libya

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ABSTRACT

Objectives: Waterborne infections and outbreaks are usually associated with contaminated and poor quality drinking water sources. The aims of the present study were to determine the bacteriological quality of drinking water from water vendors in Tripoli, Libya, isolate the potentially pathogenic bacteria from water samples and determine the susceptibility of the isolated organisms to the commonly used antimicrobial agents.

Methods: From the 2nd of February to the 2nd of March 2008, 50 drinking water samples were bought from 50 local purified-water vendors in Tripoli. Using standard bacteriological procedures, samples were examined for coliform counts and for enteric bacteria, *Aeromonas* spp. and *Pseudomonas aeruginosa*. Isolated bacteria were tested for their susceptibility to antimicrobial agents by the disc diffusion method.

Results: Coliforms were detected in 9 (18%) and *E. coli* in 4 (8%) of the drinking water samples examined. Of the 44 potentially pathogenic bacteria isolated (more than one bacterial species isolated from some samples), 18 (41%) were identified as enteric bacteria, 8 (18%) *Aeromonas* spp., and 18 (41%) *P. aeruginosa*. Multiple-drug resistance (resistance to ≥ 3 antimicrobial agents) was observed in more than 75% of the isolated organisms.

Conclusion: Multiple drug-resistant bacteria that are potentially pathogenic to humans are common in drinking water from water vendors in Tripoli. The water, environment and health authorities (particularly on the municipal level) in the country have to make sure that drinking water provided by private water vendors is of good quality and does not pose a risk to public health.

Key words:
Drinking water, water vendors, coliforms, *Aeromonas*, antimicrobial resistance, Libya.

INTRODUCTION

A fundamental requirement for good health in any community is the availability of a safe domestic water supply (1). Waterborne infections and outbreaks are usually associated with contaminated and poor quality drinking water sources. Diarrhea is the major syndrome associated with such infections and outbreaks with children being most affected particularly

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in developing countries.

Libya, one of the developing African countries, has restricted total population coverage by water supply. The World Health Organization (WHO) and United Nations Children`s Fund (UNICEF) 2000 report on global water supply and sanitation assessment states that Libya has water supply coverage of 72% (2). In Libya, traditional sources of drinking water include mainly ground water from wells and rainwater collected in underground reservoirs known as Faskia in urban centres and as Majin in mountain areas. Non-traditional sources include water from desalination plants and from the Great Man-Made River project that transfers the ground water from the massive southern basins to the densely populated areas in the north coastal stretch of the country (3). In the last decade bottled water also became available commercially as a domestic water source for drinking; however it is still not widely consumed by the majority of the population due to its high retail price.

In the last few years privately owned drinking-water vending places have mushroomed in Tripoli and other Libyan cities. Many of these places are found in shops, garages or the house backyards. The majority of water vendors apply small-capacity filtration techniques to produce drinking water from tap water. The produced water is usually kept in large plastic water tanks at room temperature. From these tanks the water is sold to the public at ¼ Libyan Dinar (1 US Dollar is equal to ~1.20 LD at the time of this study) for 5L volumes. It should be noted that these water vendors are not required to have a licence to run their business.

Therefore, the aims of the present study were to determine the bacteriological quality of drinking water from water vendors, isolate the potentially pathogenic bacteria from water samples and determine the susceptibility of the isolated organisms to the commonly used antimicrobial agents.

MATERIALS AND METHODS

SAMPLES

From the 2nd of February to the 2nd of March 2008, 50 drinking water samples were bought from 50 local purified-water vendors in Tripoli, Libya. Water samples were collected aseptically in sterile containers, placed in an ice chest and processed within two hours of collection.

MICROBIOLOGY

Water samples were examined for coliform counts by the five-tube most probable number (MPN) method (4). For isolation of enteric bacteria a loopful from each coliform-positive tube was plated onto MacConkey agar (MA) and blood agar (BA) and incubated at 37°C overnight. For isolation of *Aeromonas* spp. samples were enriched in alkaline peptone water (APW, pH 8.6) and incubated at 37°C. After overnight incubation, a loopful from APW was plated onto ampicillin BA (ABA, 10mg/L) and incubated at 37°C overnight. *Pseudomonas aeruginosa* was isolated from BA plates. Suspected colonies from MA, BA and ABA were identified biochemically using standard microbiological procedures (5) and API20E (bioMerieux, France). Speciation of *Aeromonas* species was carried out as reported previously (6). Isolated bacteria were tested for their susceptibility to antimicrobial agents by the disc diffusion method (7).

RESULTS

In the present work coliforms were detected in 9 (18%) and *E. coli* in 4 (8%) of the 50 drinking water samples obtained from water vendors in Tripoli. The coliforms MPN ranged between 0.0 - > 1.6×10^3 (mean = 1.3×10^2). Different potentially pathogenic bacteria including *E. coli* and coliforms were detected in 29 (58%) water samples. Of the 44 potentially pathogenic bacteria isolated (more than one bacterial species isolated from some samples)

Table 1. Potentially pathogenic bacteria isolated from drinking water from water vendors in Tripoli-Libya

Bacteria	No (%) positive (n=50)
Escherichia coli	4 (8%)
***Klebsiella* spp.**	1 (2%)
Enterobacter cloacae	4 (8%)
Ent. sakazaki	4 (8%)
Total *Enterobacter* spp.	8 (16%)
***Citrobacter* spp.**	3 (6%)
***Serratia* spp.**	2 (4%)
Aeromonas hydrophila	7 (14%)
A. sobria	1 (2%)
Total *Aeromonas* spp.	8 (16%)
Pseudomonas aeruginosa	18 (36%)

Table 2. Antimicrobial resistance of potentially pathogenic bacteria isolated from drinking water from water vendors in Tripoli-Libya

Antimicrobial agent	No. (%) resistant			
	Enteric bacteria (n=18)[1]	*Aeromonas* spp. (n=8)	*Pseudomonas aeruginosa* (n=18)	Total (n=44)
Ampicillin	15 (83)	8 (100)	18 (100)	41 (93)
Amoxicillin + clavulanic acid	15 (83)	8 (100)	18 (100)	41 (93)
Kanamycin	10 (56)	3 (38)	18 (100)	31 (70)
Ciprofloxacin	1 (6)	0 (0.0)	1 (6)	2 (5)
Nalidixic acid	14 (78)	7 (88)	18 (100)	39 (89)
Tetracycline	13 ((72)	4 (50)	18 (100)	35 (80)
Trimethoprim + sulphamethoxazole	8 (44)	7 (88)	18 (100)	33 (75)

1 Number tested.

from water samples, 18 (41%) were identified as enteric bacteria, 8 (18%) *Aeromonas* spp. (7 *A. hydrophila* and 1 *A. sobria*), and 18 (41%) *Pseudomonas aeruginosa*. Table 1 shows the different types of bacteria isolated from drinking water from water vendors in Tripoli.

More than 90% of the isolated bacteria were resistant to ampicillin and amoxicillin-clavulanic acid, and 75% were resistant to nalidixic acid, tetracycline and trimethoprim-sulphamethoxazole. Multiple-drug resistance (MDR, resistance to ≥3 animicrobial agents)

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was observed in more than 75% of the isolated organisms. Antimicrobial resistance profiles of the isolated bacteria are shown in Table 2.

DISCUSSION

It is well-recognized that poor quality of consumed water is an important transmission route for infectious diarrhoeal and other diseases (8). The importance of water quality affects both developed and developing countries, although the majority of the health burden is carried by children in the latter countries (9,10). Water intended for drinking or for food preparation should be of good quality and risk-free for human health (1).

Presence of *E. coli* in drinking water is an indicator of fecal contamination by humans or/and warm-blooded animals (8). In addition, the WHO`s guidelines for drinking-water quality state that coliform bacteria should not be detectable in treated water supplies and, if found, suggest inadequate treatment, post-treatment contamination, or excessive nutrients. Furthermore, the WHO`s guidelines clearly state that *E. coli* or thermotolerant coliform organisms must not be present in water intended for drinking (8). More than 25% of drinking water samples from water vendors in Tripoli examined in the present study were positive for *E. coli* and thermotolerant coliforms. This clearly indicates that at least 1/4 of the drinking water provided by water vendors in Tripoli is not suitable for human consumption according to the WHO`s guidelines for drinking-water quality.

Although their role in gastroenteritis is controversial, *Aeromonas* spp. are recognized as etiological agents of a wide spectrum of diseases in man and animals. Water-borne and food-borne outbreaks as well as nosocomial outbreaks associated with *Aeromonas* spp. have been reported from several developed and developing countries (11-15). We detected these organisms in 16% of drinking water samples examined. In Libya, *Aeromonas* spp. have been reported from 48% of drinking water from wells (6), 73% of drinking water from water reservoirs known as Faskia (16), from 60% of drinking water from water reservoirs known as Majin (K.S. Ghenghesh, unpublished data) and from 6% of drinking water samples from general supply network in Tripoli (17).

Members of the genus *Pseudomonas* are opportunistic pathogens that have been implicated in water- and food-borne diseases (18-19). Recently, *P. aeruginosa* was reported from 64% of 50 water samples collected from clay and stainless steel water containers used for drinking in mosques in Tripoli, Libya (20). Generally, the presence of *P. aeruginosa* is not desirable in treated drinking water particularly in bottled water. The organism was detected in nearly 40% of the water samples tested in the present work. The detection of *P. aeruginosa* in drinking water from water vendors in Tripoli may pose a public health problem for immunocompromised consumers of such product.

Resistance to antimicrobial drugs is a major problem that inflicts the whole world. In developing countries the situation is still worse due to lack of antimicrobial-resistance surveys and control policies. Isolation of multiple antimicrobial-resistant bacteria from drinking water has been reported previously from Libya (6,20). High rates of resistance to commonly used antimicrobials were found among the potentially pathogenic bacteria isolated from drinking water in the present investigation with more than 75% of isolates being multiple-drug resistant. Only 5% of the isolated organisms were resistant to ciprofloxacin, an important fluoroquinolone that have excellent activity against most bacterial causes of infectious diarrhea (*Salmonella* spp., *Campylobacter* spp., *Shigella* spp., *Vibrio* spp., and *Yersinia enterocolitica*). A number of studies have suggested that nalidixic acid resistance can be used as an indicator of low level resistance

to fluoroquinolones among some enteric pathogens (21,22). We found more than 75% of enteric bacteria, *Aeromonas* spp. and *P. aeruginosa* isolates were resistant to nalidixic acid.

Our findings show that multiple drug-resistant bacteria that are potentially pathogenic to humans are common in drinking water from water vendors in Tripoli. From the findings of the present study it is clear that drinking water provided by water vendors in Tripoli is of unacceptable quality (this may also apply to water vendors in other Libyan cities) and may pose a health risk to the public. It is not easy to pinpoint the source(s) of contamination of water from water vendors. However, we can speculate that the contamination could be due to failure in the filtration process, post-filtration contamination resulting from handling and keeping filtered water in tanks at room temperature before sale to the public. Also, it could be due to the fact that filtration did not occur in the first place due to lack of inspection by municipal authorities.

On the basis of population growth forecast, the Environment General Authority in 2002 reported that the drinking water requirement of Libya will be short of 1015 million cubic meters by the year 2010 (3). This indicates that the community will have to find other sources of drinking for many years to come. In the future, the private sector in the form of small-scale drinking water providers can play an important role towards filling the gap as far as the drinking water shortage is concerned in Libya. The water, environment and health authorities in the country have to make sure that drinking water provided by the private sector is of good quality and does not pose a risk to public health. This can only be achieved by informal regulation, inspection and quality assurance (particularly on the municipal level) and technical assistance provided by the above mentioned authorities to the private small-scale drinking water providers.

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