Bacterial Water Quality in the Personal Water Bottles of Elementary Students

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ABSTRACT

Background: Samples of drinking water were collected directly from the personal water bottles of students at an elementary school in Calgary, Alberta.

Methods: Total and fecal coliforms and heterotrophic bacteria were enumerated using membrane filtration and agar plate count methods respectively.

Results: The Canadian Drinking Water Quality Guidelines (CWQG) criterion was exceeded for total coliform in 13.3% of 75 samples. Fecal coliform and total heterotrophic criteria were exceeded in 8.9% (of 68 samples) and 64.4% (of 76 samples) respectively.

Findings: The use of personal water bottles for students in elementary classrooms is not recommended.

Personal water bottles are commonly used in schools and in the workplace. An elementary school in Calgary, Alberta recommended that students keep personal water bottles at their desks throughout the school day. In the absence of official instruction regarding bottle washing, some students brought clean water bottles on a daily basis, while others continually refilled the same water bottle for months without washing it. The objective of this study was to assess the bacteriological water quality in personal water bottles taken from the desks of students at this school in Calgary.

METHODS

Sampling was conducted to collect representative samples of water that the students were drinking. Any available water present in an individual student's water bottle was transferred into sterile (autoclaved at 230°C for 20 minutes) polypropylene bottles for lab analysis. Three separate classrooms were sampled over a one-week period. In total, 76 samples were collected directly from student water bottles, with sample volumes ranging from 10 to 500 mL. In addition, source water samples were collected from each of the classroom sinks and two drinking water fountains located in the school hallways. All water samples were stored at 4°C and analyzed within 18 hours of collection. Heterotrophic bacteria were quantified using Heterotrophic Plate Counts (HPC)¹ on standard HPC plate count media. Coliform bacteria were analyzed using Standard Membrane Filtration (MF)¹ techniques and m-Endo (total coliform) and m-FC (fecal coliform) media.

RESULTS

Significant levels of coliform bacteria were found in water from the students' personal water bottles (Table I). Of the 76 samples analyzed for total coliforms, 10 (13.3%) contained >10 cfu/100mL. Fecal coliforms were enumerated at >1 cfu/100mL in 6 of 68 samples analyzed (8.9%).

Heterotrophic bacteria concentrations were also elevated. Heterotrophic plate counts are used as an overall indicator of the bacterial quality of water supplies. Drinking water guidelines (>500 cfu/mL) were exceeded in water collected from

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64.4% of the bottles. These high heterotrophic counts may indicate the effect of bacterial regrowth in bottles that have remained at room temperature for an extended period. Significant bacterial regrowth has been shown to occur in treated, chlorinated water, when left at ambient temperature for as little as 8-24 hours.²

Bacterial levels from each of the five source water samples were all under the detection limits for both coliforms (i.e., <1 cfu/100mL) and heterotrophs (<10 cfu/mL).

DISCUSSION

The findings suggest that significant bacterial contamination can occur in individual water samples originating from personal water bottles. This study cannot identify the origin of contamination, however the most likely source of enteric bacteria found in the students' water bottles is the hands of the students themselves. Inadequate and improper hand washing after students have used the bathroom facilities could result in fecal coliforms in the classroom area. A study conducted within a Houston, Texas day-care isolated fecal coliforms from the hands of 17% of staff and children, and 13% of classroom objects during routine monitoring.³ These rates increased significantly during outbreaks of diarrhea. Although the transmission routes of fecal contamination in day-care centres may vary from those in primary schools, contamination of hands, taps and sinks was shown to be a reliable predictor of diarrhoeal risk.^{3,4} These same sources may potentially be the main vectors of fecal transmission from the environment to the students' water bottles in this study. A previous study conducted in a primary school in Leeds, England indicated that hygiene training significantly decreased the levels of fecal streptococci isolated from the hands of elementary children.⁵ The results obtained from this study suggest there is a need to educate students about proper hygiene practices in order to decrease the spread of coliform bacteria.

TABLE 1

Summary of Results from the Bacteriological Analysis of Water from Elementary Students' Personal Water Bottles

Range	Coliform Bacteria (cfu/100mL)		Heterotrophic plate counts (HPC) (cfu/mL)	
	Frequency (% Samples)*		Frequency (% Samples)*	
	Total Coliforms	Fecal Coliforms		
<1	85.3	91.2	<10	15.8
1-10	1.3	1.5	10-500	19.7
11-100	0‡	1.5	501-5,000	7.9
101-1,000	4.0	1.5	5,001-50,000	11.8
>1,001	9.3	4.4	>50,000	44.7
Maximum	22,300	16,800	—	>400,000
# Samples	75	68	—	76
CWQG†	0	0	—	<500
Total % exceeding CWQG†	13.3	8.9	—	64.4

* Frequency values rounded to nearest tenth of a percent

† Microbiological criteria in the Canadian Drinking Water Quality Guidelines (CWQG; which can be viewed at <http://www.hc-sc.gc.ca/waterquality>) recommend a maximum criteria of zero total coliform detectable per 100 mL, but tolerate up to 10 total coliform detectable per 100 mL in recognition of sample variability. A guideline of less than 500 HPC is set because of possible coliform inhibition, not necessarily because the heterotrophic bacteria themselves are pathogenic.

‡ bolded values exceed Canadian Water Quality Guidelines (CWQG)

Significant bacterial contamination occurred in water collected from personal water bottles. Since the source water showed no significant levels of heterotrophic or coliform bacteria, we conclude that current practices pertaining to personal water bottle care at this elementary school are not sufficient to ensure the safe bacterial quality of the students' drinking water. Drinking directly from the water fountains may be a safer alternative to water bottles.

Further study with larger sample populations and sample replication is warranted to further evaluate the risk of reusing personal water bottles.

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RÉSUMÉ

Contexte : Nous avons recueilli des échantillons d'eau potable dans les gourdes à eau des élèves d'une école primaire de Calgary (Alberta).

Méthode : Par filtration sur membrane et au moyen de tests sur plaque à la gélose, nous avons déterminé le nombre total de bactéries et le nombre de coliformes fécaux et de bactéries hétérotrophes.

Résultats : Le seuil fixé dans les Recommandations pour la qualité de l'eau potable au Canada eu égard au nombre total de coliformes a été dépassé dans 13,3 % des 75 échantillons recueillis. Le seuil pour les coliformes fécaux a été dépassé dans 8,9 % des cas (sur 68 échantillons), et celui pour l'ensemble des bactéries hétérotrophes, dans 64,4 % des cas (sur 76 échantillons).

Constatations : L'emploi de gourdes à eau par les élèves du primaire est à éviter.