BACTERIAL CONTAMINATION OF LIQUID HAND SOAPS USED IN PUBLIC RESTROOMS

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Abstract

The objective of this study was to determine the occurrence of heterotrophic and coliform bacteria in liquid hand soaps collected from public restrooms across the United States. Sample locations included public restrooms in restaurants, health clubs, office buildings and retail stores. The liquid soap samples collected were from refillable dispensers (also referred to as "open systems" or "bulk soap" systems). Of 541 samples, 133 (25%) had bacterial numbers greater than 500 /mL and 87 samples (16%) contained coliform bacteria. Approximately 65% of the bacteria isolated from the soap belonged to the coliform group. The average number of bacteria detected in the soap was 3.02 x 10^6 CFU/mL with a range of 590 to 5.3 x 10^7 CFU/mL. The average number of coliform bacteria was 3.94 x10^6 CFU/mL with a range of <10 to 6.5 x 10^7 CFU/mL. Opportunistic pathogens identified in the liquid soap samples included *Klebsiella oxytoca, Klebsiella pneumoniae, Enterobacter aerogenes, Serratia marcescens, Pseudomonas aeruginosa* and *Enterobacter sakazakii.* No bacteria were detected in dispensers that required sealed soap replacements. All of the organisms detected in the soap samples were Gram-negative bacteria. This is most likely because of the presence of sodium lauryl sulfate in the soap, which inhibits the growth of Gram positive bacteria. The results suggest that some liquid soap dispensers become colonized by Gram negative bacteria over time, possibly because of the degradation of preservatives in the liquid soap.

Introduction

Washing hands with soap and water is a universally accepted method to reduce the microbial load on the hands and is used daily by millions of people worldwide. However, the majority of public facilities have soap dispensers that are refillable using a stock soap solution. The CDC recognized in 1975 that the use of these type of dispensers can result in a suitable environment for the growth of potentially disease causing microorganisms. Current hand hygiene guidelines still do not recommend the use of open refillable dispensers. The liquid soap used in these dispensers can become contaminated regardless of the preservative used when the microbial population exceeds the preservatives defenses. When product contamination has been reported, contamination was more likely to have occurred extrinsically (after product had been used) than intrinsically (during manufacturing). The likelihood of extrinsic contamination is greatest when the product is open to repeated exposure to bacteria from the user or the environment, hence, the packaging and the dispensing method plays a significant role in product safety.

Materials and Methods

Liquid soap samples were collected from public restrooms in five cities [Boston, MA (107), Atlanta, GA (120), Columbus, OH (109), Los Angeles, CA (94), and Dallas, TX (111)]. Samples were organized into 5 categories: office, health clubs, food service, retail locations and other (education, leisure, etc.). All samples were confirmed to be from open refillable systems.

The samples were collected in sterile 50 mL conical tubes and shipped to the laboratory on ice. 1 mL of DE neutralizing broth (Remel, Lenexa, KS) was added to each sample tube and shaken vigorously for 60 seconds. Heterotrophic plate counts (HPC) were obtained by the spread plate method on R2A media (Difco, Sparks, MD). Plates were incubated at 30°C for 5 days. Any sample showing bacterial content was reexamined for Coliform bacteria.

Coliform analysis and enumeration was performed using the spread plate method on mEndo agar (Difco, Sparks, MD) and incubated at 35°C for 24 hours. Bacterial colonies were counted and recorded, representatives of all colony types were subcultured to TSA plates (Difco, Sparks, MD) for oxidase tests and identification. TSA plates were incubated at 35°C for 24 hours. Identification of bacteria was obtained using API20E strips (BioMerieux, Marcy-l'Etoile, France).

S. aureus analysis was performed by using the spread plate method on TSA amended with 5% Sheep Blood (BA) (Hardy Diagnostics, Phoenix, AZ) to check for hemolysis. Plates were incubated for 24-48 hours at 35°C. Beta hemolytic isolates were enumerated and streaked onto a TSA plate and incubated for 24 hours at 35°C. Isolated colonies underwent further confirmation testing utilizing catalase production, microscopic morphology, coagulase production (tube and slide tests) and antibiotic (polymyxin) sensitivity.

A Sealed System

0% Contaminated

Open refillable bulk soap dispenser being refilled

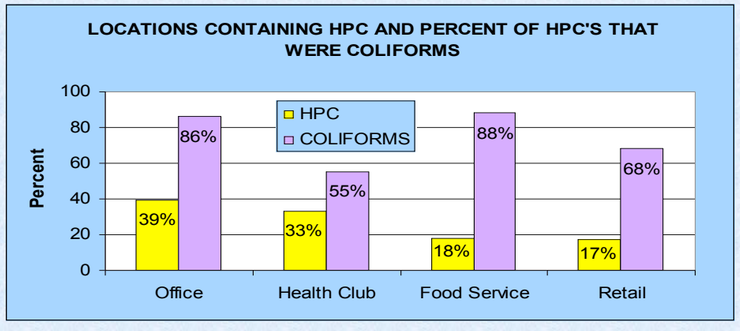
25% Contaminated

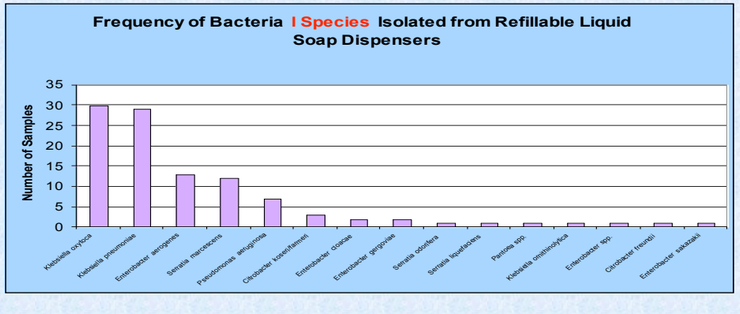
Results

The total number of liquid soap samples analyzed in this report were 541, consisting of 428 soap samples from the sink area and 113 soap samples from showers. Samples with <500 colony forming units (CFU)/mL were not considered since industry standards allow for this amount of bacteria in liquid soap.

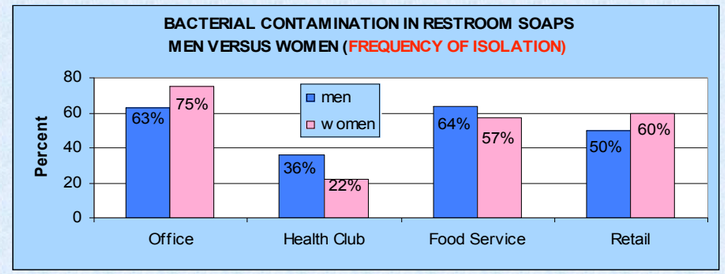
Total Number of Open Refillable Soap Samples	Number of Samples with Bacteria	Number of Samples with Coliforms
541	133 (25%)	87 (16%)

Heterotrophic bacterial numbers detected in the liquid soap samples ranged from 590 to 5.3x10^7 CFU/mL. The average number of bacteria found in one mL of soap was 3.02x10^6. Coliform bacteria ranged from <10 to 6.5x10^7 CFU/mL in liquid soap samples, with an average of 3.94x10^6 per mL of soap. No *Staphylococcus aureus* were detected in any of the liquid soap samples analyzed.

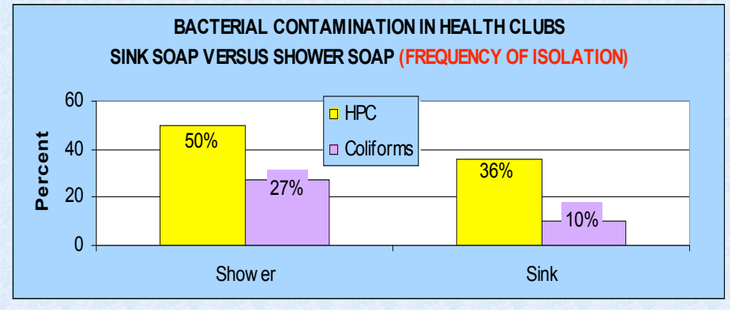




A total of 428 liquid soap samples from the sink area, 226 from men's restroom and 202 from women's restroom were analyzed.



A total of 113 liquid soap samples were from the shower area at health clubs, 65 from men's showers and 48 samples were from women's showers.



Summary

A total of 541 open refillable liquid soap samples were analyzed for bacteria, coliforms and *Staphylococcus aureus*. Of the 541 samples, 133 (25%) contained bacteria and 87 samples (16%) coliforms. The frequency of contamination was similar for all cities tested, for both men and women's restrooms and wall mounted and counter dispensers. The percent of bacteria isolated from open refillable liquid soap samples that were identified as coliforms was 65%. The average number of bacteria was 3.02x10^6 CFU/mL with a range of 590 to 5.3x10^7 CFU/mL. The average number of coliforms was 3.94x10^6 CFU/mL with a range of <10 to 6.5x10^7 CFU/mL. No *Staphylococcus aureus* was detected. *Klebsiella* was the most frequently isolated genus of bacteria, followed by *Enterobacter* and *Serratia*.

Conclusions

High levels of bacterial contamination (average 3.02x10^6 CFU/mL) were found in 25% of the liquid soap samples in this study. Since these samples represent a diverse cross section of geographical locales and individual sites, it is concluded that refillable open, or "bulk", liquid soap systems commonly found in the U. S. are routinely contaminated with bacteria. Many of the bacteria isolated are opportunistic pathogens which can cause a variety of health issues including respiratory infections, bloodstream infections, urinary tract infections and skin infections. The type and level of bacteria found in these systems represent a potential health risk to users, especially to any immunocompromised individuals.

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