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Bacterial Occurrence in Kitchen Hand Towels

ABSTRACT

The common occurrence of enteric bacteria in kitchen sponges and dishcloths suggests that they can play a role in the cross-contamination of foods, fomites and hands by foodborne pathogens. This study investigated the occurrence of bacteria in kitchen towels often used to dry dishes, hands and other surfaces in the domestic kitchen. A total of 82 kitchen hand towels were collected from households in five major cities in the United States and Canada and the numbers of heterotrophic bacteria, coliform bacteria, and *Escherichia coli* in each towel were determined. In addition, identification of the enteric bacteria was performed on selected towels. Coliform bacteria were detected in 89.0% and *E. coli* in 25.6% of towels. The presence of *E. coli* was related to the frequency of washing.

INTRODUCTION

Several studies have documented the common occurrence of large populations of heterotrophic and enteric bacteria in kitchen sponges and dishcloths *(1, 2, 5, 8)*, where the moist environment and collected food residues create an ideal environment for the growth of bacteria. Enriquez et al. *(2)* found total and fecal coliform bacteria in large numbers in cellulose sponges and dishcloths, sometimes reaching levels greater than 10^6 colony-forming-units (CFU) per ml in fluid squeezed from these cleaning tools. *Salmonella* spp. was isolated from almost 14% of the dishcloths. Scott et al. *(8)* documented the occurrence of *E. coli* in kitchen towels, and Mattick et al. *(4)* reported isolation of *Camplyobacter* from tea towels in the kitchen after preparation of meals made with poultry. Scott and Bloomfield *(6)* documented the survival of *Salmonella* and *E. coli* in cotton kitchen cloths and suggested they may play a role in cross-contamination in the home environment. The goal of this study was to assess the occurrence of total and enteric bacteria in kitchen towels as it relates to environmental and towel cleaning.

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MATERIAL AND METHODS

The study was conducted in five major cities in North America: Chicago, IL; Tucson, AZ; New Orleans, LA; Orlando, FL and Toronto, ON, Canada. The numbers of towels collected from each city is presented in *Table 1*. These cities represent different weather conditions, varying from cold to hot and from dry to humid.

Random households were selected in each city and towels were collected by going door to door and requesting one used towel from the kitchen. A survey of household towel use and characteristics also was conducted for each house selected. The information was obtained from the person in the household who provided the towel. A total of 82 kitchen towels were collected.

The questions in the survey were related to towel use and frequency of cleaning. These questions identified: age of towel in months, frequency of washing of towel in days per month, towel frequency of use, and the number of days since the towel was last washed.

Each collected and used kitchen towel was submerged in peptone broth (Difco, Sparks, MD) to extract bacteria from the towel. Each towel was placed in a stomacher bag with either 500 or 250 ml of peptone broth, based on towel size and the material's absorbance, to guarantee full soaking of the towel. Each towel was then manually kneaded in the peptone broth (Difco, Sparks, MD) for five minutes until the broth was completely absorbed by the towel. The broth was extracted from the towel by wringing the liquid out by pressing it against two stainless steel metal plates (AK Steel, Cincinnati, OH). The extract or dilution (10-fold dilutions in peptone broth) was plated on selective media for isolation of the various bacterial populations.

Each towel was tested for total bacteria (heterotrophic bacteria counts; HPC), coliform bacteria, and *Escherichia coli.* HPC were assayed by spread plating on R2A media (Difco, Sparks, MD) or after dilution (in phosphate buffered saline). After incubation for 5 days at 25°C, viable colonies were counted. Coliforms and *E. coli* were assayed by the most probable number (MPN) method, using the Colilert Quanti-tray method (IDEXX; Westbrook, ME), and enumerated after incubation at 35°C for 24 hours. A maximum of 100 ml of the towel extract could be assayed by this method. Selected coliforms and presumptive *E. coli* isolates from randomly selected towels were picked from petri plates and identified by use of API bacterial identification test kits 20E (bioMérieux, Marcy-l'Etoile, France).

The average area of the kitchen towels, for all cities, was calculated to be about 1000 cm^2, with a standard deviation of 150 cm^2. Therefore, it was decided to do all analyses on a per towel basis.

A database was developed, and all collected data from the survey and the laboratory analytical data were entered in the database (see *Tables 1 through 3*). Data were manipulated in various manners and multiple analyses of variance (ANOVA) were conducted on the data to assess relationships between demographics and characteristics of the towels and their use. Microsoft Excel was used for the analysis (Microsoft Corp., Redmond, WA). A completely randomized design was used to perform the ANOVA, with a rejection region of 5% using the *F* distribution.

RESULTS

The results for overall occurrence of the studied bacteria are presented as both arithmetic and geometric averages

TABLE 1. Average arithmetic mean of bacterial populations found on kitchen hand towels (CFU or MPN) collected from various cities

City	HPC*			Coliforms			*E. coli*		
	Mean	St. Dev	n	Mean	St. Dev	n	Mean	St. Dev	n
Chicago	2.98E + 08	6.12E + 08	19	4.76E + 03	1.10E + 04	20	6.00E + 00	1.92E + 01	20
Tucson	1.62E + 08	2.31E + 08	19	2.55E + 06	1.11E + 07	20	1.51E + 03	6.73E + 03	20
New Orleans	9.42E + 08	1.19E + 09	4	5.50E + 03	4.02E + 03	4	1.05E + 01	1.33E + 01	4
Orlando	8.30E + 07	1.38E + 08	18	3.97E + 05	8.64E + 05	19	7.24E + 03	1.68E + 04	19
Toronto	9.49E + 07	2.22E + 08	19	1.04E + 04	2.24E + 04	19	1.34E + 00	4.80E + 01	19
Average/Total	**3.16E + 08**		**79**	**5.93E + 05**		**82**	**1.75E + 03**		**82**

*HPC: Heterotrophic Plate Count

TABLE 2. Average geometric means of bacteria found in kitchen towels (log_{10} CFU or MPN/towel) collected from various cities

City	HPC*			Coliforms			*E. coli*		
	Geo. Mean	St. Dev	n	Geo. Mean	St. Dev	n	Geo. Mean	St. Dev	n
Chicago	6.8	1.9	20	2.0	1.4	20	0.3	0.4	20
Tucson	7.6	1.3	20	3.4	1.8	20	0.4	1.0	20
New Orleans	8.3	1.1	4	3.7	0.3	4	0.7	0.7	4
Orlando	7.3	1.4	19	3.9	2.1	19	1.6	1.7	19
Toronto	6.1	1.7	19	2.8	1.4	19	1.3	0.5	19
Average/Total	**7.2**		**82**	**3.2**		**82**	**0.9**		**82**

*HPC: Heterotrophic Plate Count

TABLE 3. Statistical differences between parameters studied for kitchen towels collected in the study

Parameter	HPC*	Coliforms	*E. coli*
Between cities	**<u>≤0.009</u>**	**<u>≤0.006</u>**	**<u>≤0.0003</u>**
Age of towel (<12 or >12 months)	0.446	0.481	0.424
Frequency of washing (<3 or >4 days)	0.675	0.351	**<u>0.014</u>**
Frequency of use (<7 times a day or >8)	**<u>0.012</u>**	0.981	0.780
Last time washed (1 day vs. >2)	0.066	0.321	0.172

*HPC: Heterotrophic Plate Count
Note: Bold and underlined values indicate significant differences ($P < 0.05$).

(Tables 1 and 2). Figure 1 shows that all kitchen towels for the 5 cities had at least 1×10^3 CFU/towel, and some had HPC greater than 1×10^9 CFU/towel. The overall average was 3.16×10^8 CFU/towel. At least one MPN of coliform bacteria was found on towels collected from most cities, and values higher than 1×10^6 MPN were observed in two cities (Tucson and Orlando).

E. coli concentrations on kitchen towels were about one MPN per towel, but values as high as 1×10^4 CFU/towel were observed in some cities. Coliform bacteria were detected in almost all of the towels (89.0%) and *E. coli* in 25.6%.

The highest numbers of bacteria per towel were found in those collected from New Orleans and the lowest in towels collected from Orlando *(Table 1 and Fig. 1)*. Tucson had the

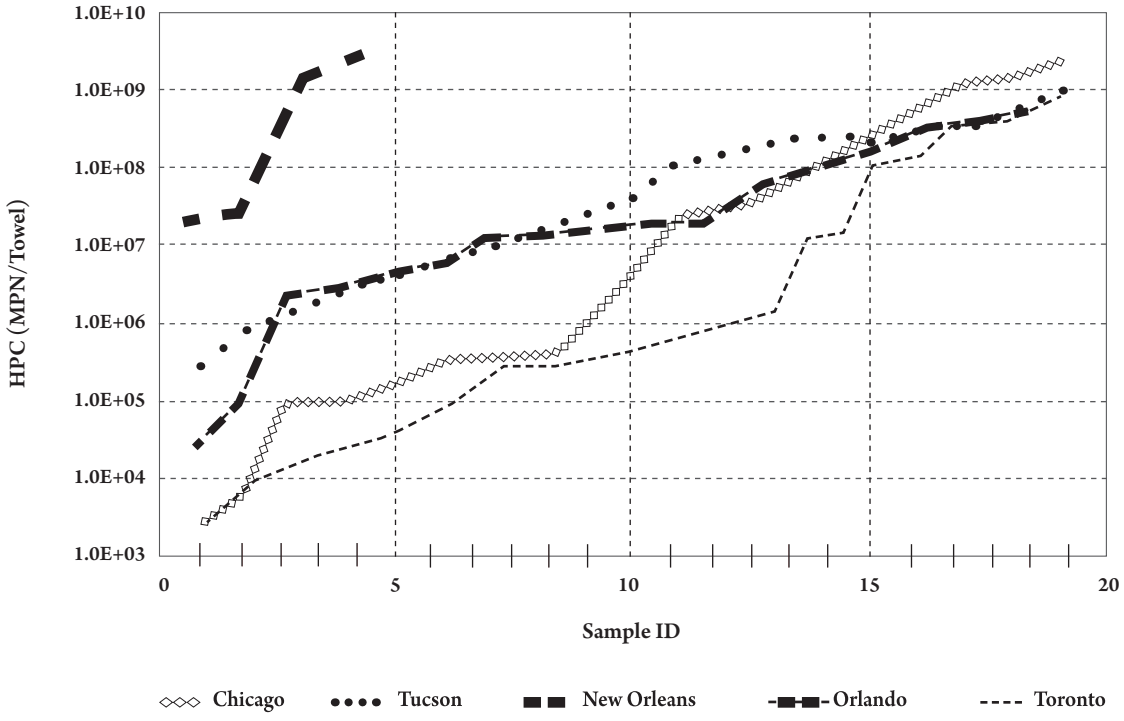

FIGURE 1. Distribution of heterotrophic plate counts (HPC) found in kitchen towels collected from various cities; each value represents an individual towel.

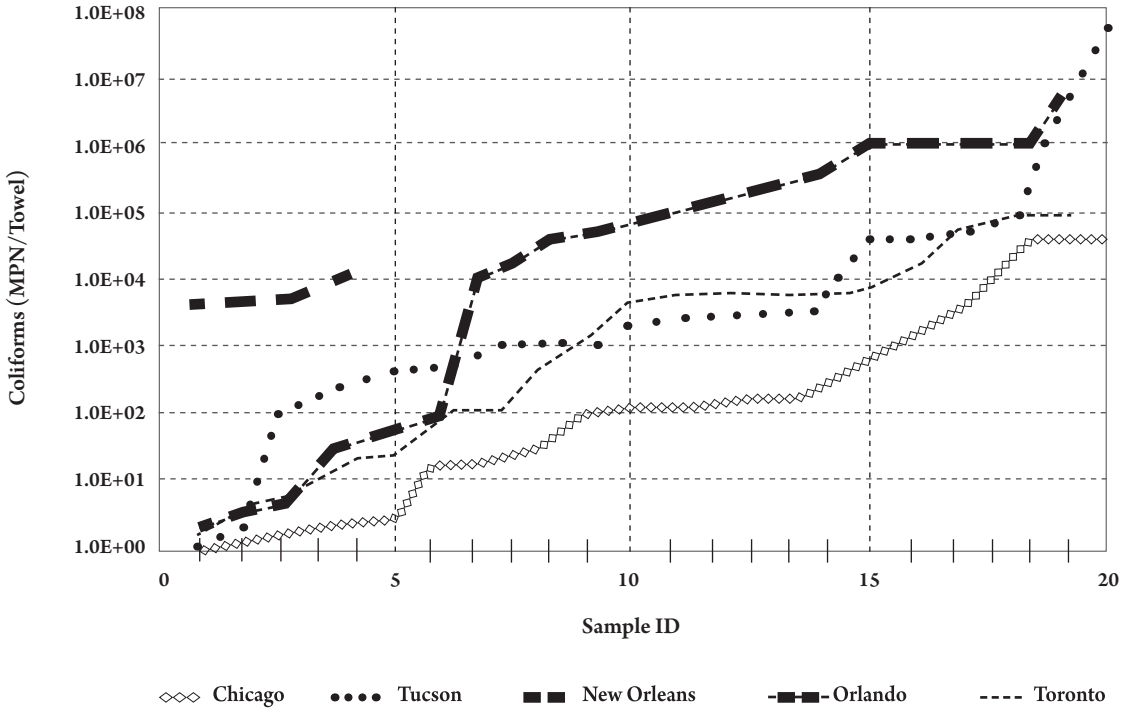

FIGURE 2. Distribution of coliform bacteria numbers found on kitchen towels collected from various cities; each value represents an individual towel.

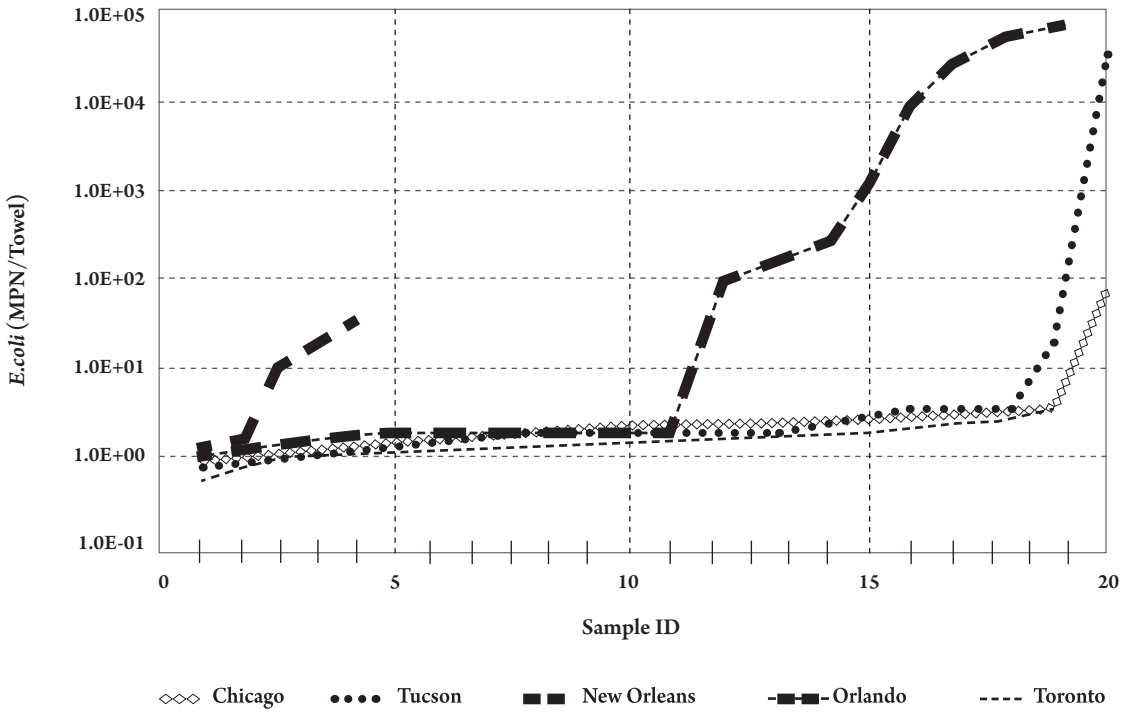

FIGURE 3. Distribution of E. coli found on kitchen towels collected from five of the cities studied; each value represents an individual towel.

highest numbers of coliform bacteria in the towels, followed by number of *E. coli* isolated from towels collected in Orlando *(Table 1 and Figures 2 and 3)*.

Because the distribution of the bacteria exhibited a log normal distribution, it was log transformed for further analysis *(Table 2)*. There was a statistically significant relationship between city of collection and all types of bacteria isolated. Frequency of use was related to the numbers of HPC, while the concentration of *E. coli* was related to the frequency of washing. In addition to *E. coli*, other bacteria identified in the towels included *Enterobacter cloacae, Klebsiella pneumonia* and *K. oxytoca.*

DISCUSSION

This is the first study to address the concentrations and types of enteric bacteria in kitchen hand towels. Scott et al. *(8)* studied the occurrence of bacteria in kitchen towels in the United Kingdom but sampled the surfaces only by use of Rodac plates. In that study, *E. coli* was detected in 1.9% and coliforms in at least 4.1% of the kitchen towels. The genera of bacteria detected in their study were similar to the ones observed in the present study. We detected coliforms in 89.0% and *E. coli* in 25.6% of the towels. The greater numbers we observed are most likely because we extracted the bacteria from the towel using an eluent to obtain a total count of the bacteria on and within the towel.

The relationship between the numbers of bacteria and the different cities (excluding New Orleans, since it had so few samples) was statistically significant, which may reflect climate and different use patterns or types of food prepared. Statistically significant lower numbers of HPC occurred in towels that were washed less *(Table 3)*. *E. coli* numbers also were related to the frequency of washing, with numbers on towels being lower the more often they were washed. Age of the towel and days since last time washed did not influence the concentration of any of the bacteria in the towels. The results suggest that *E. coli* is particularly easily removed during washing or requires an unusually long time to colonize and grow in the towels. Coliforms, *E. coli* and *Salmonella* can survive the drying of kitchen cleaning cloths and regrow if the cloth becomes soiled again *(3)*.

Mattick et al. *(4)* also reported the isolation of *Camplyobacter* from a kitchen towel of a domestic kitchen after preparation of chicken naturally contaminated with the organism. The researchers attributed the isolation of this pathogen to poor hand washing, followed by wiping of the dirty hands after handling the chicken. The same group reported cross contamination of dishes when wiped dry with towels contaminated with *E. coli* O157:H7, *Salmonella* or *Campylobacter jejuni (4)*. The researchers recommended frequent replacement or decontamination of kitchen towels. Scott and Bloomfield *(7)* reported that detergent washing and drying of kitchen cloths in the kitchen only slightly reduced microbial

contamination, and regrowth occurred within 24 hours, since the towels remained damp. The researchers demonstrated that soaking the cloths in 4,000 mg/L of bleach for two minutes was more effective in reducing bacterial numbers; however, not all the cloths could be decontaminated, probably because of differences in organic load.

This current study demonstrated that significant numbers of coliform and *E. coli* commonly occur in kitchen towels. These results also demonstrate the potential for cross-contamination of foodborne enteric bacterial pathogens and their growth in kitchen towels.

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