Letter to the Editor

Microbial Presence on Kitchen Dishcloths in Chinese Housholds

SHEN Jin[1,2,†], ZHAO Bin Xiu[2,†], LI Tao[2], BAN Hai Qun[2], TIAN Liang[3], GE Yi Lin[3], CHEN Tai Yao[3], LI Shi Yue[1], and ZHANG Liu Bo[2,#]

To study the microbiological contamination of kitchen dishcloths in Chinese housholds, 1010 'in-use' kitchen dishcloths were collected from residential premises in Beijing and Shanghai, and they were sent to the laboratory for microbiological quality analysis. The aerobic plate counts for dishcloths were 10-10^9 cfu/cm^2 in the range of 150 cfu/cm^2 to 1.776×10^9 cfu/cm^2 (Beijing) and 62.5 cfu/cm^2 to 8.75×10^8 cfu/cm^2 (Shanghai). Nineteen species of bacteria were detected in the dishcloths, most of which were conditional pathogenic bacteria. This study found a significant difference in the aerobic plate counts of dishcloths with regard to type, number of the days used, activities used for, and some family factors. The findings of the study highlight the potential for contamination of kitchen dishcloths within homes.

Studies have suggested that although raw material is probably the main source of contamination in the kitchen, the area surrounding the kitchen could also provide sources of free-living populations of bacteria. Sponges and dishcloths have been recognized as potential agents in the spread of microorganisms, and bacteria have been shown to persist in these vehicles[1-3]. Several studies have indicated that various bacteria, including *Escherichia coli*, *Staphylococcus aureus,* and *Salmonella* spp., survive on hands, sponges/dishcloths, utensils and currency for hours or days after initial contact[4-5].

One aspect of kitchen hygiene is the use of dishcloths for general surface wiping and washing. Despite the introduction of disposable paper products such as kitchen towels, most domestic kitchens in China (about 95%) still have dishcloths for wiping surfaces and cutting boards. These dishcloths are typically rinsed under the tap after use and stored damp. Because they are seldom dried or disinfected, they comprise a prime microbiological habitat. Again, there are very few evidence-based data from recent investigations-obsolete figures may not be reliable against the background of the use of modern detergents and kitchen surfaces. The limited available information suggests that, although total microbial populations in these cloths may be high (perhaps in the hundreds of millions per cloth), pathogens are sometimes not always present. Unfortunately, no published information or empirical data are made available in regards to microbiological quality of domestic kitchen dishcloths in China. Hence, the present study was aimed to conduct specific investigation to provide relevant information in this respect.

A total of 1010 'in-use' kitchen dishcloths were collected from residential premises in Beijing and Shanghai. Houses were selected at random and the study cohort included all property types. A questionnaire was completed for each premise. The document contained a series of standard questions relating to kitchen dishcloths, including type, number of the days used, activities used for (wiping surfaces, washing up), and some information about the family (profession, household size, etc.). When the 'in-use' kitchen dishcloths were collected, new dishcloths were given with a handbook about domestic hygiene. Samples were collected in a sterile sample bag and returned to the laboratory within 4 h for bacteriological analysis. Upon arrival at the laboratory, a 4 cm×4 cm sample of each dishcloth was diluted in 20 mL tryptone physiological saline for 10 min and then subjected to a 1:10 dilution[6]. Using the pour plate technique, 1 mL of each sample and dilution was plated with tryptone soya agar medium and incubated at 37 °C for 48 h, and bacterial species were identified using a VITEK2 bacterial identification system (BioMerieux, America).

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1. School of Public Health, Wuhan University, Wuhan 430071, Hubei, China; 2. Institute of Environment Health and Related Product Safety, Center for Disease Control and Prevention of China, Beijing 100021, China; 3. Center for Disease Control and Prevention of Shanghai, Shanghai 200336, China

In this study, 506 and 504 dishcloths were collected in Beijing and Shanghai, respectively. Houses were selected at random and the household information differed among houses. Professions of the individuals completing the questionnaires included doctors (3.86%), teachers (4.36%), the employed (9.78%), managers (16.44%), workers (27.33%), and the retired (38.23%). Annual income of the study population per household was: <50,000 RMB in 54.46%, 50,000-100,000 RMB in 24.95%, >100,000 RMB in 9.50%, and unknown in 11.09%. A total of 40.79% of the households had children under the age of 14, while 33.37% included elderly family members. Households contained 1-8 members: ≥5 members in 14.55%, 4 members in 19.7%, 3 members in 37.82%, ≤2 members in 22.87%, and unknown in 5.06%. Towel, sponge, cloth, and fiber dishcloths were collected. The dishcloths were used for washing up, wiping surfaces or both. The number of days used and the frequency of changing dishcloths differed among households. All the information above is shown in Table 1.

Most of the aerobic plate counts for the dishcloths were 10^4-10^7 cfu/cm^2 and very few samples had low (10) or high (10^9) values in the range of 150 cfu/cm^2 to 1.776×10^9 cfu/cm^2 (Beijing) and 62.5 cfu/cm^2 to 8.75×10^8 cfu/cm^2 (Shanghai). The median, inter-quartile range, geometric means, and range of the aerobic plate counts for the different dishcloths types are shown in Table 2. This result was well supported by other authors who highlighted that the bacterial counts were high in the dishwashing sponges in the kitchen[7-9].

In this study, we detected 19 species of bacteria from the dishcloths, most of which were conditional pathogenic bacteria. These species included *Sphingomonas paucimobilis*, *Citrobacter freundii*, *Aeromonas sobria*, *Enterobacter cloacae*, *E. coli*, *S. aureus*, *Kocuria kristinae*, *Kocuria varians*, *Staphylococcus sciuri*, *Enterococcus columbae*, *Acinetobacter ursingii*, *Burkholderia cepacia*, *Pseudomonas luteola*, *Pseudomonas putida*, *Pantoea* Gavini et al., *Candida albicans*, *Salmonella*, *Streptococcus* spp., and *Listeria monocytogenes*, some of which had been investigated in other studies, for example *Salmonella*, *Streptococcus* spp., and *Listeria monocytogenes*, but most of which were reported in research of dishcloths for the first time. The relationship between the microbiological quality of dishcloths and human diseases was not analyzed in the present study, as it was not its objective, and this omission might represent a limitation of our study.

A non-parametric Wilcoxon signed rank test was used to compare the aerobic plate count measurements observed from dishcloths in Beijing and Shanghai. The effect of type, length of use, and activity of use upon the bacterial loading of the dishcloths was investigated. *P* values <0.05 were considered statistically significant.

Table 1. Different Characteristics of Dishcloths Used in the Two Cities

Cities	Type (number)				Activities Used (cases/times)			Number of Days Used (days)				Frequency of Changing Dishcloths (days)			
	towel	sponge	cloth	fiber	Washing up	Wiping surfaces	both	<14	14-30	30-90	≥90	<14	14-30	30-90	≥90
Beijing	35	164	306	1	262	149	89	0	1	361	109	87	146	178	80
Shanghai	192	46	263	3	229	136	115	44	151	159	77	48	200	164	59

Table 2. Distribution of Aerobic Plate Counts for the Dishcloths

Cities	Sample Type	Percentage(%)	Number of Samples (n/N)	Median (cfu/cm^2)	Inter-quartile Range (cfu/cm^2)	Geometric Mean (cfu/cm^2)	Range (cfu/cm^2)
Beijing	towel	6.92	35/506	2.73×10^6	8.79×10^6	1.39×10^6	1.79×10^8
	sponge	32.41	164/506	1.51×10^7	9.73×10^7	6.55×10^6	1.78×10^9
	cloth	60.47	306/506	5.34×10^6	2.34×10^7	2.75×10^6	1.02×10^9
	fiber	0.20	1/506	8.88×10^6	0	8.88×10^6	0
Shanghai	towel	38.10	192/504	1.82×10^5	1.97×10^6	1.82×10^5	2.48×10^8
	sponge	9.13	46/504	1.27×10^6	3.05×10^7	4.72×10^5	3.40×10^8
	cloth	52.18	263/504	9.75×10^5	1.30×10^7	7.02×10^5	8.75×10^8
	fiber	0.59	3/504	3.58×10^7	1.14×10^8	5.02×10^7	1.14×10^8

A statistically significant difference was observed in the aerobic plate count measurements from the different types of dishcloths (Beijing χ^2=18.62, P<0.01; Shanghai χ^2=14.294, P=0.001). The bacterial loading of the sponges was significantly larger than that of the cloths and towels possibly as a result of differences in surface characteristics. The results of this study support those of other studies. The sponge's cavernous structure may offer a protective microenvironment that facilitates microbial attachment and survival compared to the more exposed surfaces of the cloth and towel[10].

Plate counts were significantly higher in samples from households with children than those without children in Beijing (Z=-3.4, P=0.001). Dishcloths may be used more frequently in households with children than in those without children, because more frequent cooking may take place in the former. This increased the pollution probability. A statistically significant difference was also observed in the aerobic plate count measurements among dishcloths used for different activities (χ^2=9.164, P=0.01). The counts were significantly higher in dishcloths used for washing-up than in those used for wiping surfaces (Z=-2.98216, P=0.003), but no significant difference was seen among the other activities (P>0.05). Food residue adheres easily to the dishcloths used for washing-up than to those used for wiping surfaces, which promotes the growth of microorganisms. Therefore, the dishcloths used for washing-up are more likely to breed bacteria.

A significant difference was noticed in the aerobic plate count measurements among various family annual incomes (χ^2=13.21, P=0.001). Plate counts were significantly greater in families with low annual income (<50,000 RMB) than in those with high one (50,000-100,000 RMB) (Z=-2.087, P=0.037). This might be related to the family health status and health habits. High income families might spend more money on disposable paper products, thus reducing the frequency of use of dishcloths, or they changed dishcloths more frequently.

A statistically significant difference was also observed in the aerobic plate count measurements in terms of number of days used (χ^2=12.914, P=0.005). Plate counts were significantly greater in those samples from dishcloths that were used for more than 90 d than within 14 d (Z=-2.102, P=0.036), 30 d-90 d than within 14 d (Z=-3.038, P<0.01) and 14 d-30 d than within 14 d (Z=-3.5, P<0.01), but no significant difference was seen among these three periods (P>0.05). All of the investigated dishcloth types established large numbers of microorganisms after short-term use. Dishcloths become heavily contaminated with a diverse microbial population after a short period of use (within 14 d), and this maximal loading did not increase significantly over extended periods (up to 14 d), although the population would almost certainly have been dynamic. This study showed that only 13.37% of the families changed their dishcloth within two weeks; most of them, in fact, changed their dishcloth far less frequently than every two weeks.

Dishcloths can easily accumulate bacteria and are widely used within about 95% of the households in China. However, this potential health hazard has not been paid enough attention. Our study was a success to indicate the microbiological quality of kitchen dishcloths in households and the habitual factors which could affect it within China.

Many studies have found that dishcloths used in kitchens have high bacteria levels, including *Salmonella* and *E. coli*. Limited hygiene knowledge of dishcloths users may lead to the spread of food borne illness. Here are some simple tips that can help reduce the possibility of cross contamination caused by dishcloths in households.

1.Replace cleaning cloths with paper towel/single use cloths, or replace cleaning cloths on a regular basis, especially if frayed or torn.

2.Isolate dishcloths for different areas with different colors, and use cloths in a designated place in the kitchen to prevent from being reused before washing.

3.Wash the dishcloths after each use, and disinfect them on a regular basis.

† These authors contributed equally to this work.

#Correspondence should be addressed to ZHANG Liu Bo, Tel: 86-10-67717125, Fax: 86-10-87779905, E-mail: zlbxj@263.net

Biographical notes of the first authors: SHEN Jin, Female, born in 1982, MS, Research Associate, majoring in disinfection and infectious disease prevention and control; ZHAO Bin Xiu, Female, born in 1966, Chief technician, majoring in disinfection.

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