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Microbial assessment of kitchen dishcloths for the presence of targeted bacteria

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Abstract

Background: Dishcloths play a crucial role in keeping kitchen surfaces hygienically clean; however, they can also spread pathogens from spilled food to hands and other food items. The present study aimed to investigate the microbial load of dishcloths, with a specific focus on pathogenic bacterial contaminants they potentially harbor.

Methods: A total of 50 samples were collected from households in the Hyderabad district of Pakistan. Specific media were used to isolate the bacteria. Additionally, the hygiene of dishcloths was evaluated visually, and questionnaires were administered to gather information on the various purposes of dishcloths, the source of water used, and the socio-demographic details of the participants.

Results: The results showed that 42 out of 50 dishcloths had poor hygiene conditions. Almost half of the participants (48%) used the dishcloth for cleaning their kitchen surfaces, and only 18% of the participants washed it daily. Microbial assessment of dishcloths revealed widespread pathogenic contamination. Nearly all dishcloths tested positive for various microorganisms; 98% for total coliforms, 84% for *Staphylococcus aureus*, 82% for *Vibrio cholerae*, 74% for *Shigella*, 54% for *Salmonella*, 54% for *Escherichia coli*, and 26% for *Pseudomonas aeruginosa*. No significant relationship was found between the frequency of dishcloth washing and the presence of total coliforms, as determined by the Kruskal-Wallis H-test ($H = 2.981$, $P = 0.561$).

Conclusion: The high level of microbial contamination in dishcloths can potentially transmit pathogens and cause infections. Implementing effective disinfection methods, such as boiling or regular washing with detergent, is essential to prevent pathogen transmission.

Keywords: Hygiene, *Salmonella, Escherichia coli*, Disinfection

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Introduction

Foodborne epidemics have been reported worldwide, characterized by significant morbidity and posing a health risk to the human population (1). The microbial burden continually rises in environments with constant access to both water and air. After the washroom, the kitchen is the second most established location for microbial growth in a household environment (2). Several surveys show consumers frequently engage in risky kitchen habits (3-5). In the kitchen, dishcloths are regularly used household items that frequently come into contact with food. The use of kitchen dishcloths or sponges in conjunction with detergent or soap to wash and clean utensils and kitchen surfaces is considered one of the numerous household hygiene practices that are popular in homes today (6). Before being cleaned, dishes may include pathogenic microorganisms from food spoilage. The bacteria from these microorganisms stick to the sponge during washing, stay there, and occasionally cross-contaminate other surfaces (7). They can harbor a variety of bacteria, making them a leading cause of food contamination in kitchen settings. According to multiple studies, if consumers are unaware of adequate hygiene measures, such as proper use and maintenance of dishcloths, food-borne infections can spread, and pathogens can become a source of cross-contamination (8-10).

Dishcloths act as both habitats and vectors for bacterial contaminants. Elevated temperature, moisture, and leftover food cause the bacteria to multiply rapidly and quickly reach high numbers (11). A report published in 2015 by the World Health Organization (WHO) states that in 2010, there were almost 600 million incidents of contaminated food, 350 million of which had to do with harmful bacteria (12). Dishcloths can spread organisms to

other places, and total counts of up to 3.0×10^{10} have been enumerated on them (11,13,14). Drying dishes, cleaning kitchen surfaces and pots, and handling utensils are ways dishcloths are used in the kitchen (15). Compared to other kitchen fabrics, a dishcloth used for drying dishes, pots, pans, and kitchenware has a higher risk of contamination (16). Cutting boards and other surfaces used in food preparation are frequently contaminated by organic matter when dishcloths are used to clean or wipe them (17). If dishcloths are later utilized without being properly cleaned, they provide an ideal environment for microbes to proliferate (3).

Numerous studies have revealed that dishcloths and kitchen sponges frequently contain a significant quantity of enteric and heterotrophic bacteria (18-21), where the humid atmosphere and accumulated food leftovers provide a perfect habitat for bacterial growth. Studies have isolated various bacteria from kitchen dishcloths and sponges, including coliforms, *Salmonella*, *Shigella*, *Escherichia coli*, *S. aureus*, and *Campylobacter* (22).

Coliforms are particularly concerning, as they indicate contamination from raw food, especially raw meats, or inadequate personal hygiene among kitchen workers (23). Food safety education programs should concentrate on teaching people how to correctly handle and care for common home goods like dishcloths and kitchen sponges, as they may act as potential vectors and reservoirs for contamination in consumer kitchens (24).

In the study conducted by Sharma and Eastridge (25), dishcloths contaminated with *S. aureus*, *Salmonella*, and *Shigella* were found to transfer these pathogens to stainless steel surfaces. Notably, *S. aureus* bacteria were able to survive on these surfaces for up to four days. Similarly, the contaminated dishcloths also spread pathogens onto stainless steel surfaces at varying rates when in contact with chopped vegetables (26).

Escherichia coli is frequently employed to detect faecal contamination, despite certain strains having the potential to cause diarrhea (27). Some variations of *E. coli* can produce a toxin known as Shiga, which causes illness. This toxin can harm the inner lining of the intestine (28). In this study, *E. coli* was utilized as an index organism to determine whether dishcloths used in homes can be considered a factor in the development of diarrhea. *Pseudomonas* spp. is an opportunistic organism that causes gastrointestinal infections, a wide range of systemic infections, respiratory tract infections, dermatitis, soft tissue, and joint infections, and urinary tract infections (UTIs). This opportunistic pathogen is one of the most common contaminants in the food industry and is considered a model microorganism for biofilm formation and control (29). Due to the bacterium's propensity to thrive in moist environments, kitchen surfaces, and dishcloths are particularly susceptible to contamination. Once a Pseudomonas infection is established, it can be challenging to manage because this bacterium often develops resistance to several commonly used antibiotics (30). *S. aureus*, the leading cause of infections in humans, is a round-shaped gram-positive bacteria with a wide range in environment and food surfaces. It can transfer through contact surfaces such as dishcloths, hands, and kitchen tops (31).

Studies about kitchen hygiene in general are already conducted in developing countries like Pakistan. However, a very limited number of studies have been conducted, particularly on kitchen dishcloths, concerning the frequency of cleaning and washing practices in developing countries like Pakistan. In this study, we have attempted to identify the pathogenic bacterial species harbored by dirty dishcloths as potential sources of disease. Specifically, the study focuses on total *coliforms*, *E. coli*, *P. aeruginosa*, *Salmonella* spp., *Shigella* spp., *S. aureus*, and *Vibrio cholerae*. The present research promotes hygienic behavior and proposes practical solutions for eradicating these microbes in kitchen dishcloths by recommending appropriate disinfectants. In addition, we also try to find any correlation between the correlation between total coliforms isolated from dishcloths and household sociodemographic.

Materials and Methods

Study area

The study area "Hyderabad" region is divided into four administrative units, which are considered relevant populations for our study (Latifabad, Qasimabad, Hyderabad rural, and Hyderabad city). Hyderabad is located on the east bank of the Indus River and is the second-largest city in Sindh and the fourth-largest metropolis in Pakistan. It is situated approximately 150 km (93 miles) from Karachi, the provincial capital. According to Pakistan's 2017 Census, Hyderabad is home to 1 732 693 people, reflecting an increase of 565 799 since the 1998 Census, with a growth rate of 48.5%, the slowest among Pakistan's 10 major cities. The city experiences a hot, dry climate with warm weather year-round.

Sample collection

A convenient sampling method was used to select 50 households from Hyderabad's four administrative units. Hyderabad has a hot, dry climate with warm weather all year, which characterizes a population of over 1.5 million. Cotton dishcloths (approx. one sq. ft.) were distributed among selected household residents from four areas of Hyderabad such as Latifabad (n = 17), Qasimabad (n = 12), Hyderabad city (n = 11), and Hyderabad rural (n = 10). Household residents were allowed to use dishcloths in their kitchens freely. Dishcloths were selected over sponges because they are more commonly used for multiple purposes, such as drying dishes, cleaning kitchen surfaces, and handling utensils. Unlike sponges, dishcloths are not

discarded after a few days; they can be washed and reused repeatedly and are also cheaply available in the market.

Sample Processing

The study was approved by the Institutional Review Board of the US-Pakistan Center for Advanced Studies in Water before the execution of the project. Formal written permission was sought from the head of each household before the start of the study. The participants were provided with detailed information before the sampling process. Before distribution, each dishcloth underwent a decontamination process. They were washed with detergent, dried in an oven to remove moisture, and autoclaved for 15 minutes at 121 °C. This sterilization was necessary because dishcloths sold in open markets might contain pathogens. After sterilization, the dishcloths were distributed to households, where respondents were instructed to use them in their kitchens for 7–10 days. After this period, the dishcloths were collected and placed in sterilized Ziploc plastic bags to prevent cross-contamination. Within four hours of collection, the dishcloths were transported to the microbiology laboratory of USPCAS-W, MUET under aseptic conditions. In the lab, the dishcloth samples were analyzed for the presence of *E. coli*, *Salmonella* spp., *Shigella* spp., *S. aureus*, *P. aeruginosa*, and *V. cholerae*.

The samples were examined for the presence of total coliforms, *E. coli*, *P. aeruginosa*, *Salmonella* spp., *Shigella* spp., *S. aureus*, and *V. cholerae* using techniques outlined by the International Standardization Organization (ISO). Each collected dishcloth was homogenized in a 200 mL phosphate-buffered saline (PBS) solution for 2 minutes, as described elsewhere (24). Then, serial dilutions of up to 10^{-3} were prepared from that homogenized solution and further analyzed for the targeted bacteria.

Isolation of bacteria

Selective media were used to isolate targeted bacteria, and each type of bacteria was cultured separately. The selective media used in the study and incubation conditions for the bacteria are as follows: Eosin methylene blue (EMB) agar for total coliforms (temperature = 35 °C, time = 24 hours), Tryptone bile X-Glucuronide (TBX) agar for *E. coli* (temperature = 44 °C, time = 24 hours), Cetrimide agar for *P. aeruginosa* (temperature = 35 °C, time = 48 h), xylose lysine deoxycholate (XLD) selective agar for *Salmonella* spp. and *Shigella* spp. (temperature = 37 °C, time = 48 hours), mannitol salt agar for *S. aureus* (temperature = 35 °C, time = 72 hours) and thiosulfate-citrate-bile salts-sucrose (TCBS) agar for *Vibrio cholerae* (temperature = 37 °C, time = 24 hours), as shown in Table 1. All agars were provided by OXOID (Basingstoke, UK).

Questionnaire survey data

A questionnaire survey was included in the study, comprising two sections: demographic details and usage of dishcloths at the household level. The demographic information included household income, number of family members, position of the key food preparer in the family, participant's education level, and usage of dishcloths.

The questions related to the usage of dishcloths included the frequency of washing the dishcloth, the frequency of using the dishcloth, and the number of days since the dishcloth was last washed.

During the field survey, the researcher personally visited the participants' kitchens and observed their hygienic conditions. A section for personal observations was included, describing the condition of the dishcloth and the kitchen as either good/bad or clean/dirty. Kitchens that visually appeared clean were rated as good, and those with spotless conditions were described as having very good hygienic conditions.

Statistical analysis

Data were entered and analyzed using SPSS version 25. The prevalence of bacteria was calculated by dividing the number of samples positive for bacteria from the total number of samples processed. Percentages were calculated to present the prevalence of the contamination. The Kruskal-Wallis H-Test was used to examine the frequency of washing dishcloths and the presence of total coliforms. The relationship between income, family units, education level, and water source with bacterial colonies (total coliform) was determined using Pearson's correlation. Moreover, the relationship between various bacteria was also determined, and results were presented

Table 1. Selective media for targeted bacteria and incubation conditions

Targeted bacteria	Selective media	Incubation conditions		
		Temp (℃)	Time (h)	Environmental conditions
Total coliforms	Eosin Methylene Blue	35	24	Aerobic
Escherichia coli	Tryptone bile X-glucuronide	44	24	Aerobic
Pseudomonas aeruginosa	Cetrimide agar	35	48	Aerobic
Salmonella	Xylose lysine deoxycholate	37	48	Aerobic
Shigella	Xylose lysine deoxycholate	37	48	Aerobic
Staphylococcus aureus	Mannitol salt agar	35	72	Aerobic
Vibrio cholera	Thiosulfate-citrate-bile salts-sucrose	37	24	Aerobic

through triangular heat maps.

Results

The study comprises two parts: 1) a questionnaire-based survey and 2) a laboratory analysis of the targeted pathogens.

Questionnaire-based survey

The survey results are presented in Table 2. As shown in this table, most households (46%) have a monthly income ranging from 10 000 to 50 000 rupees, while 38% fall within the 51 000 to 100 000 rupees range. Only 16% of households earn more than 100 000 rupees per month. Among the 50 households surveyed, 39 consist of a single family member, three have two family units, seven have three, and one has four family members. The essential proprietor, typically the primary kitchen user, was queried about their education level. Notably, 10 out of 50 key proprietors had received only primary education. Thirty-eight key proprietors had completed secondary education, and a substantial proportion (42%) held a graduation degree.

Regarding water sources, 70% of households relied on surface water supply, while only 24% had access to groundwater. Interestingly, 6% had both surface and groundwater supply. A visual assessment of kitchen hygiene revealed that only one kitchen was in very good condition, while the remaining 13 were considered good. Twenty out of fifty kitchens fell into a neutral category—neither good nor bad—while 16 were classified as bad kitchens (Figure 1). Lastly, observations on dishcloth hygiene indicated that 42 out of 50 dishcloths were dirty, with only eight in good condition (Figure 2).

Table 2. Socio-demographic characteristics of the participants

Characteristics	Frequency (n = 50)	Percent
Monthly income of household (Rupees)		
10 000 to 50 000	23	46
51 000 to 100 000	19	38
More than 100 000	8	16
Number of family units		
One	39	78
Two	3	6
Three	7	14
Four	1	2
Education level of the key proprietor		
Primary	10	20
Secondary	19	38
Graduation	21	42
Above graduation	0	0
Source of water supply		
Surface water	35	70
Groundwater	12	24
Both	3	6
Other	0	0

The questionnaire also acquired information regarding the purpose of the dishcloth, as shown in Figure 3. Almost half of the participants, 24 (48%), used the dishcloth for cleaning their kitchen surfaces, 12 (24%) participants used it for drying their dishes, followed by 10 (20%) of participants using it for cleaning kitchen surfaces and handling utensils, 2 (4%) participants used it only for handling utensils, and remaining 2 (4%) used it for drying dishes, cleaning surfaces, and handling utensils (2%).

Laboratory analysis for the presence of targeted bacteria in dishcloths

Based on the enumerated colonies of recovered bacteria from dishcloths, the samples were categorized into three types: non-detectable, having < 103 CFU/100 mL, and having > 103 CFU/100 mL. The total coliform bacteria were present in most of the samples; specifically, 86% of samples had more than 103 CFU/100 mL. Conversely, only 2% of samples had non-detectable CFU/100 mL for

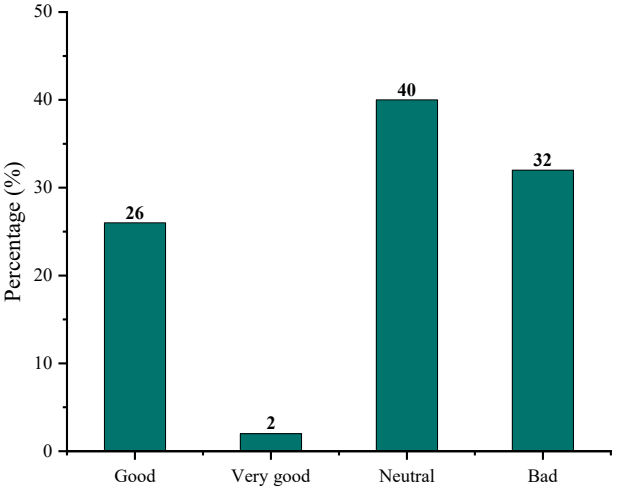

Figure 1. Hygienic condition of kitchen

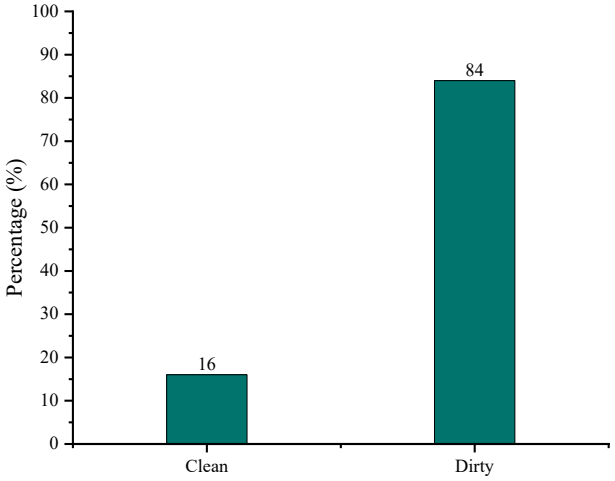

Figure 2. Hygienic condition of dishcloth

total coliforms. Following total coliforms, *S. aureus* was the second most commonly present pathogen in the samples, with 66% of samples having > 103 CFU/100 mL. *Shigella*, *V. cholerae*, and *Salmonella* were found in 60%, 58%, and 48% of samples, respectively, with > 103 CFU/100 mL. *P. aeruginosa* was the least prevalent pathogen among all targeted bacteria, occurring in only 20% of samples with > 103 CFU/100 mL, while a substantial number of samples (74%) had non-detectable CFU/100 mL. *E. coli* was found in 44% of samples with > 103 CFU/100 mL, as presented in Figure 4.

During the survey, participants were asked about their dishcloth-washing frequency, and their responses were recorded. Table 3 shows five participant groups based on washing habits: those who wash their dishcloths daily, once a week, twice a week, three times a week, and more than three times a week. Notably, over a quarter of participants (28%) reported washing their dishcloths twice weekly. Additionally, 22% washed them three times a week, 20% washed them once a week, 18% washed them daily, and only 12% washed them more than three times a week. Given that total coliforms were the most prevalent bacteria, we investigated their relationship with dishcloth washing frequency using the Kruskal-Wallis H-test. The results showed no statistically significant association between dishcloth washing frequency and the presence of total coliforms (H = 2.981, *P* = 0.561).

We employed Pearson's correlation to assess the relationship between total coliform counts (which were the highest among all targeted bacteria) and various factors: family monthly income, family unit count, key proprietor's education level, and water source. Surprisingly, no significant associations were found between total coliform colonies and any of these variables (Figure 5). Additionally, the bacterial associations based on colony-forming units (CFU) are categorized as non-detectable, low (< 103 CFU/100 mL), or high (> 103 CFU/100 mL). Figure 6 presents the correlation matrix. Notably, there is a strong positive correlation between total coliforms and *Salmonella* and between *Pseudomonas* and *Salmonella*. Furthermore, *E. coli* and *V. cholera* exhibit a moderately

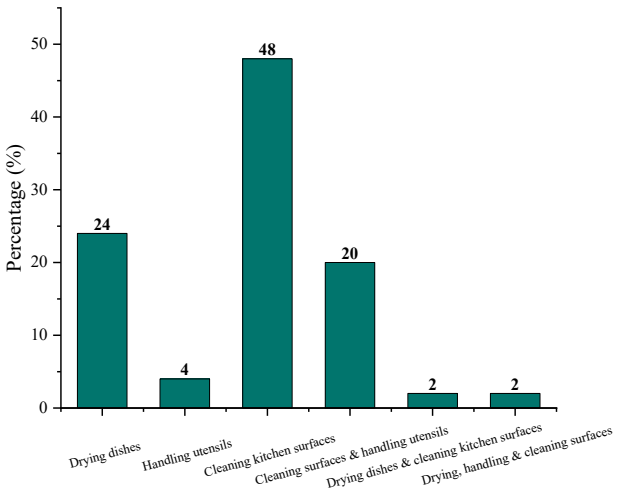

Figure 3. Different uses of dishcloths

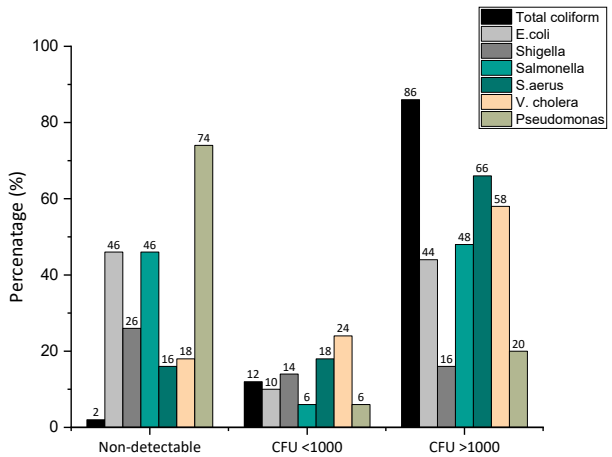

Figure 4. Percentage (%) of isolated bacteria at different concentrations

Table 3. Frequency of washing dishcloths

S#	Frequency of washing dishcloths	Percent
1	Daily	18
2	Once a week	20
3	Twice a week	28
4	Three times a week	22
5	More than three times a week	12

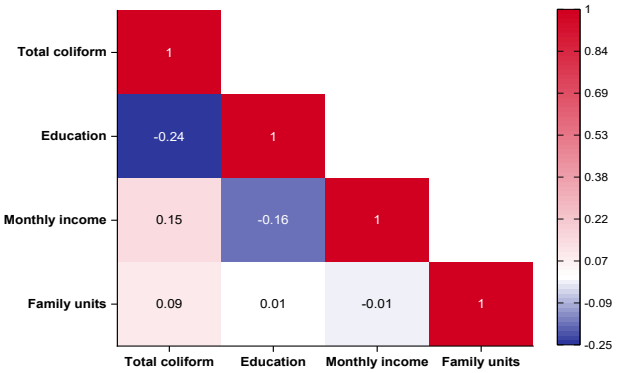

Figure 5. Correlation between total coliforms and household sociodemographic

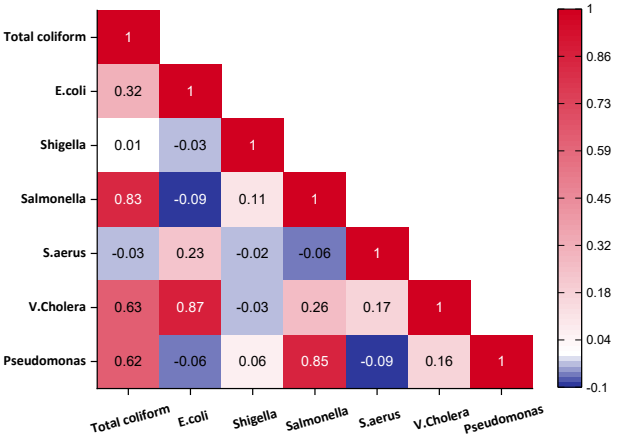

Figure 6. Correlation between total coliforms and household conditions

strong positive correlation ($r > 0.7$). Meanwhile, total coliforms and *V. cholera* show a positive correlation ($r < 0.7, > 0.5$).

Discussion

Dishcloth usage and microbiological contamination serve as crucial indicators of kitchen hygiene and food handlers' adherence to safety practices. The present study revealed that individuals who use reusable dishcloths often lack proper handling knowledge, with some using them for multiple purposes. Previous research consistently highlights that dishcloths and sponges become contaminated over time due to repeated use, potentially leading to cross-contamination of dishes and kitchen surfaces (32,33). To evaluate the hygienic status of dishcloths, our study isolated seven potential bacteria from the samples: total coliforms, *E. coli*, *Shigella, Salmonella*, *S. aureus*, *V. cholerae*, and *P. aeruginosa*. The results demonstrated that all dishcloth samples were contaminated with these targeted bacteria, albeit at varying concentrations. These findings align with observations from a few previous studies (2,8,9,27).

Total coliform bacteria were detected in the majority of samples and these findings align with a study by Keshav et al (27), where 81% of dishcloth samples exhibited total coliform counts exceeding 103 CFU/100 mL. However, unlike the previous study, our investigation did not reveal a significant correlation between total coliform counts and dishcloth washing frequency. Additionally, the finding of coliforms in dishcloths indicates the presence of feces and may indicate the presence of food pathogens. The reasons for this could include inadequate hygienic and sanitary measures taken during food preparation, contaminated raw materials, inadequate disinfection protocols, cross-contamination, and storing sponges in environments with elevated moisture content and suitable temperature to promote microbial development (34).

Staphylococcus aureus is a foodborne pathogen that produces an enterotoxin, which can cause digestive problems after eating contaminated food. Dairy products like raw milk are significant sources of contamination (35,36). In the present study, the second most highly occurring pathogen found in dishcloths was *S. aureus*, with 84% of dishcloths contaminated with it. These results contradict the findings of Scott et al (37), who found only 27% of dishcloths with these bacteria in household kitchen settings. In another research, 4% of dishcloths had *S. aureus*, which ranged in population from 10^2 to $4.0\text{-}10^4$ CFU ml^{-1} (38). According to reports, *Staphylococcal* food poisonings are ranked third among all foodborne illnesses globally (39) *Staphylococcal* poisoning symptoms often appear quickly, three hours after ingesting the toxin (40).

Another important bacterium isolated from dishcloths was *E. coli.* The prevalence of *E. coli* found in this study is much higher than in the survey conducted in the kitchens of the United States, where only 33% of dishcloths were contaminated with *E. coli* (41). Another study by Shayeghi et al in Tehran found only 0.9% of *E. coli*. However, current findings are consistent with the results of the study of Keshav et al (27) in which 40% of samples had cultivable *E. coli* counts, and 17% had $> 10^3$ CFU/100 mL. The presence of *E. coli* in kitchen settings has been given particular consideration because of its presence in high counts, the ineffectiveness of inactivation at low doses, and resistance to some chemical and physical disinfection treatments (38).

Most raw foods, including fruits, vegetables, meat, dairy products, poultry, and eggs, are associated with *Salmonella*, leading researchers to explore it as a food-borne pathogen that finds its way to the kitchen environment (14). It has been suggested that $< 10^3$ *Salmonellae* may cause disease. In the present study, 50% of samples were found to be contaminated with *Salmonella.* The prevalence of *Salmonella* in the present study is much higher than in Tesfaye and Ketema's (15) study in Jimma town in Ethiopia (41) and Ramli, Salman et al. (42).

In a later study, *Salmonella* was isolated from 10% of restaurants' kitchen dishcloths, 11.9% of hotels' dishcloths, 12.1% of pastry shops' dishcloths, and 12.8% of cafeteria kitchens. Some of the reasons for the presence of *Salmonella* in the dishcloths involved the use of contaminated water, incorrect sanitizing procedures, or post-sanitizing/washing contamination caused by improper handling (15).

Shigella species are highly contagious bacteria that can spread via the oral-fecal pathway. Gastrointestinal diseases can be brought on by as little as 10 bacteria cells (32,33). Shigellosis symptoms include cramping in the stomach, diarrhea, fever, vomiting, and blood or mucus in the stools. They appear 12 to 50 hours after consuming contaminated food or drink. In the present study, the prevalence of *Shigella* was found to be 74%, which is much higher than the study of Anwar (18), who found 6.56% of dishcloth samples were contaminated, and Shayeghi et al (5), who only found 0.9% of contamination in samples with *Shigella.*

The concentration of *Pseudomonas* spp. found in this study is less than that in the study of Erdoğrul and Erbilir, who isolated it from 31% of dishcloths (43), however, it is much higher than that in the study of Møretrø et al conducted in Germany who isolated it from only 5% of samples (22). Due to its preference for humid environments, *P. aeruginosa* is more likely to exist on kitchen countertops and soiled dishcloths. Due to its amazing ability to withstand antibiotics, eradication has become more challenging (44).

In terms of washing dishcloths, the results of the present study are in contrast with the results of the study of Shayeghi et al (5) conducted in urban settings of India, in which 70% of the study population washed the dishcloths

daily, 22% washed twice a day, and 8% washed them once in two days.

In the study, no significant associations were found between total coliform colonies and the socio-demographic variables such as education level, income of household owner, and other socio-demographic details. It shows that the household owners with higher education levels and high income levels also maintained the same level of hygiene in terms of cleaning dishcloths.

Due to their high levels of contamination, dishcloths have the potential to transmit infections. Consequently, an efficient decontamination method is necessary to ensure that these types of cloth pieces do not transmit pathogens. Different disinfection methods have been recommended in various studies, mainly conventional boiling (45), and sodium hypochlorite solution (25). Even though all the disinfection methods can reduce the microbial load from dishcloths, the boiling method was found to be the most effective in inactivating microorganisms, with a removal rate of 99.99% (45). The high temperature of the water, which can denature proteins, and thus, compromise the integrity of cell membranes resulting in the death of microorganisms, is one explanation for the success of the boiling method (13).

According to the findings of the experimental study of Bassan et al (46), it was found that the bacterial number reduced with increased microwave radiation exposure. *E. coli* was discovered to be the most susceptible to microwave radiation. With one minute of exposure, *E. coli* was decreased by 91.54%, and by three minutes, it completely disappeared. Other methods of reducing the number of microorganisms on dishcloths have been suggested, including laundering without bleach and dishwashing (47) or microwaving (25) to reach high temperatures required for cell death, frequent replacement of dishcloths, or rinsing.

According to the study by Alhazmi (8), washing with detergent and drying kitchen dishcloths only significantly contributed to the decrease in microbial food contamination. Since the towels were still moist, regrowth was observed within 24 hours. Another study found that soaking the clothes in 4000 mg/L of bleach for two minutes was more efficient in reducing bacterial count (15). Treatments involving sponges and brushes with chlorine, boiling, or dishwasher cycles were effective in reducing *Salmonella* contamination (48). Alternatively, disposable wipes could serve as a suitable alternative, although financial considerations may influence the preference for reusable dishcloths (2). Drying dishcloths in sunlight after washing and changing the dishcloth at least weekly will also help reduce microbial contamination.

The present study had several limitations. Firstly, we focused on selected pathogens based on existing research. However, future studies should explore additional foodborne contaminants to comprehensively understand dishcloth contamination and identify suitable disinfectants. Secondly, our study was conducted on a small scale; given the concerning results, larger-scale investigations are warranted. Lastly, clinical implications related to contaminated dishcloths were not addressed in this study. Future research should examine the potential impact of such contamination on the prevalence of foodborne diseases within the study population. Additionally, probability models could estimate health and economic risks, providing valuable insights for policymakers.

Conclusion

In the present study, nearly all dishcloths exhibited some level of pathogenic contamination. Surprisingly, most food proprietors were unaware of the necessity for dishcloth sanitation, often washing them only once or twice a week. Alarmingly, one-third of participants used the same dishcloth for multiple purposes, posing a significant risk of foodborne diseases within the study population. To mitigate this threat, policymakers should launch a targeted media campaign emphasizing the importance of hygienic dishcloths, specifically addressing household food proprietors. Promoting proper hygiene practices can reduce the risk of pathogen cross-contamination.

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Authors' contributions

Conceptualization: Rija Shakir.
Data curation: Rija Shakir.
Formal analysis: Sadaf Tagar.
Investigation: Rija Shakir.
Methodology: Rija Shakir.
Software: Sadaf Tagar.
Supervision: Jamil Ahmed.
Visualization: Faheem Mahmood.
Writing-original draft: Sadaf Tagar.
Writing-review & editing: Jamil Ahmed.

Competing interests

The authors declared no conflicts of interest.

Ethical issues

The study adhered to the guidelines outlined in the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board (IRB) of the US-Pakistan Center for Advanced Studies in Water (Approval No: 18MSWASH06)

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