**RESEARCH ARTICLE**

# Evaluating microbiological quality of kitchen equipment in school canteens

**Rosnaini P. Ramli, Hanis Syakira Salman, Lea Nursuria Sariza Sazari, Alia Azmi***

*Centre of Environmental Health and Safety, Faculty of Health Sciences, Universiti Teknologi MARA Cawangan Selangor Kampus Puncak Alam, 42300 Bandar Puncak Alam, Selangor, Malaysia*

***Corresponding Author**

Alia Azmi
Email: aliaazmi@uitm.edu.my

**Abstract:**

Food preparation requires constant safety and health supervision and careful handling of raw materials. Due to the nature of processes occurring during food preparation, equipment within any food establishment will come into contact with various types of microbiological organism. If cleanliness is not ensured, equipment such as dishwashing sponges and cutleries can be a source of contamination, leading to foodborne diseases. This is a serious health hazard, especially if it occurs within a setting that has vulnerable populations, such as a school canteen. As such, this study aims to evaluate the microbiological quality of kitchen equipment in school canteens, as well as the effectiveness of the cleaning agents used in the kitchen. Carried out in three schools in Puncak Alam, microbiological swabs were obtained from sponges, cutleries and plates used in each of the school canteen. Based on the microbiological analysis, *Salmonella* was detected the highest (mean; 4 log10 cfu/ml), compared to *E. coli* (mean; 3.4 log10 cfu/ml) and *S.aureus*, which showed the least growth (mean; 2.05 log10 cfu/ml).

**Keywords:** Food hygiene, kitchen equipment, microbiological quality

## 1. INTRODUCTION

Every school, regardless of primary, secondary or kindergarten, has its own canteen. It is commonly known that during cleaning process for kitchen utensils and equipment, sponges are used to eliminate food residues. However, food residues will stick to the sponge surfaces and if stored in favorable environment for the microbial growth, kitchen sponge will turn into a medium that promotes bacterial growth.

Food hygiene is an important factor in food preparation. This is because biological food contamination can easily occur if proper hygiene is not practiced. Biological contamination such as bacteria, viruses, fungi, protozoa and helminthes are major causes of foodborne diseases, all of which with severities that range from mild to chronic, or life threatening, or both [1]. In this study, school canteen is selected because it generally produces a large quantity of meal for the students. The contamination of food by pathogen at school canteen will result in the occurrence of food borne disease amongst a large number of people.

The incidence of food borne disease such as diarrhea and abdominal pains, which are mostly reported by the students after eating at the school are presumed as microbial food poisoning [1]. Incidence of food borne disease highlights the issue of food hygiene preparation, which includes factors such as food handler hygiene, equipment, utensils, storage and raw material preparation. Even preparing meals too early and stored at incorrect temperature will allow microbial growth.

This study evaluates the microbiological quality of different kitchen equipment at school canteens. The laboratory work includes determining microbial count in used kitchen sponge, identifying presence of bacteria in kitchen cutleries washed by used kitchen sponge and investigating the effectiveness of detergent used in different school canteens.

## 2. METHODOLOGY

### 2.1 Determination of Microbial Count in Used Kitchen Sponges

Samples were taken from three different school canteens located in Puncak Alam, Selangor. The schools were labelled with SC1, SC2 and SC3 onsite to differentiate the samples. The samples were taken after receiving permission from the headmaster of each school. The sampling activities took place in the month of October 2019.

During the sampling, aseptic techniques were implemented to avoid cross contamination of the samples. The sample, which is kitchen sponge, is not based on any specific types of sponge but rather depending on whichever type of kitchen sponge used in the school canteen. For SC1 and SC3, polyethylene sponges were used while SC2 used a stainless

steel sponge. Once collected, the samples were stored in an icebox with a temperature of approximately 0 - 4°C and were taken back to the laboratory for culture process.

In the laboratory, the sponge samples were aseptically cut in 8cm³ and placed into Vortex Shaker approximately for 30 seconds. After dilution, the sample was pipetted to make 3 dilutions: 1] 10 times, 2] 100 times and 3] 1000 times. The sample of 100 µl from each serial dilution is pipetted and plated on MacConkey agar for subculture of *E. coli* and *Salmonella spp.* and on Mannitol Salt agar for *S. aureus*. After 72 hours, total colony count for Mannitol Salt Agar are counted [2].

The subculture procedure is conducted for *E. coli* and *Salmonella* spp. by referring to the method from [3]. The sub culturing process was done by isolating the target colony streaked onto other agar which is Eosin Methylene Blue and Xylose Lysine Deoxycholate.

### 2.2 Identification of Bacterial found on Kitchen Cutleries Washed by Used Kitchen Sponges

The contamination of food contact surfaces along with poor handling method by food handlers may increase the risk of foodborne disease through cross-contamination. Contamination of food contact surfaces such as kitchen counter, kitchen cutlery, and equipment is mainly caused by ineffective cleaning procedure of the food contact surface [4]. Dry environmental swab test was used to identify the presence of pathogenic bacteria on kitchen utensils, which is plates and spoons [5].

### 2.3 Determination of Efficiency of Detergent Used in School Canteen

Microorganism test - The effectiveness of detergents used was measured by performing the disc agar diffusion method. The samples were tested for three types of bacteria, which were *E.coli*, *Salmonella* and *S.aureus*, similar with the bacteria tested for kitchen sponge. The bacteria were provided by University Teknologi Mara (UiTM) Puncak Alam's microbiology laboratory. The bacteria was inoculated in peptone broth for 24 hours before pipetted into Muller-Hilton agar.

Detergent selection and sensitivity screening - The detergent selected was based on detergent used by the school canteen which was *Glo* for SC1, *Axion Lemon* for SC2 and *Kuat Harimau* for SC3. The samples were labeled as DSC1, DSC2 and DSC3 representing each school canteen respectively. Since DSC2 and DSC3 is a paste type of detergent, both were reconstituted in sterile water to obtain a stock solution prior to testing. For DSC2 and DSC3, 0.17 g/ml and five-dilution stocks were used for the test. The disk agar diffusion method procedure was done in biosafety cabinet. The petri dish were divided into three sections for each detergent tested. Each section represent one sample that was taken and was labelled (DSC1, DSC2, DSC3). Whatman filter paper sized about 6mm was placed into each section. A drop of sample was dropped on the filter paper. The plates were incubated for 24hours at 37°C. The diameter of inhabitation zones was measured and recorded

## 3. RESULTS AND DISCUSSION

### 3.1 Determination of Microbial Count in Used Kitchen Sponges in School Canteen

This study was carried out in a sterile laboratory in order to ensure no cross contamination. The sample agar plates were incubated for 24 hours at a temperature of 35°C - 37°C for *E. coli* and *Salmonella;* and for 72 hours at the same temperature for *S.aureus*. After the spread and incubation, the bacteria colony formed was counted. The total colony count ($Log_{10}$ cfu/ml) was then used to determine the level of bacterial growth. The data are presented in the following Figure 1 and 2

*E. coli* Growth – As presented in Figure 1, the growth of *E. coli*, which is 4.27 $log_{10}$ cfu/ml from SC2, was the highest total colony count. This is followed by 4.23 $log_{10}$ cfu/ml from SC1. The lowest total number of total colony count was for SC3, which is 2.70 $log_{10}$ cfu/ml. The mean of the total colony count of *E.coli* for all school canteens was 3.4 $log_{10}$ cfu/ml.

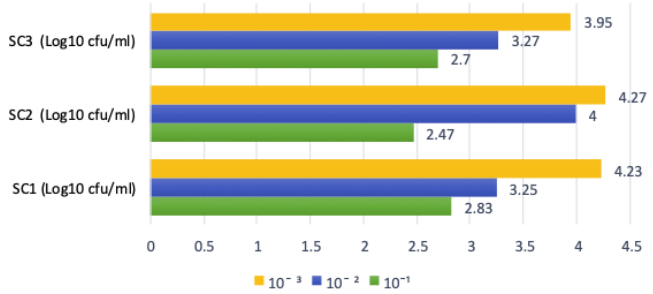


Figure 1. *E.Coli* growth in kitchen sponges.
Values are in $Log^{10}$ (10 in multiplication), Cfu/ml (colony forming unit per milliliter) according to amount of dilution respectively

In a study by [6], sponges in households are used daily and is in contact with dishwashing liquid at least twice a day. The study also showed an increasing growth of *E. coli* in used kitchen sponge, which supports the findings of our study. The study also noted that, although raw food is probably the main source of contamination, other kitchen surfaces such as sink, waste trap, cleaning cloth, face cloths and surrounding area could also act as semi-permanent source or reservoir which harbor and encourage the establishment of bacterial growth. [7] stated that *E. coli* 0157 serotypes may attach to the sponge more firmly and therefore transfer less frequently than *E.coli* ATCC11229 serotypes. *E.coli* 0157 serotypes, unfortunately are associated with foodborne disease such as abdominal cramps, bloody diarrhea and vomiting.

The occurrence of *E. coli* on kitchen sponge may potentially come from food handlers with poor hand washing hygiene. Even though most of healthy adult will recover from *E. coli* illness within a week, some particularly young children and older adult may develop life threatening form of kidney failure called hemolytic uremic syndrome [8]. This situation might increase the occurrence of foodborne illness.

*Salmonella* Growth - Figure 2 presents the number of total colony count for salmonella from three different school canteens at three levels of dilution. Based on the calculated

result, the highest total colony count is from SC2, at 5.13 $\log_{10}$ cfu/ml at $10^3$ dilution. This is followed by 4.96 $\log_{10}$ cfu/ml from SC1 at $10^3$ dilution. The lowest total colony count was from SC1, which was 2.51 $\log_{10}$ cfu/ml at $10^1$ dilution. The mean of the total colony count from *Salmonella* spp. was 4 $\log_{10}$ cfu/ml

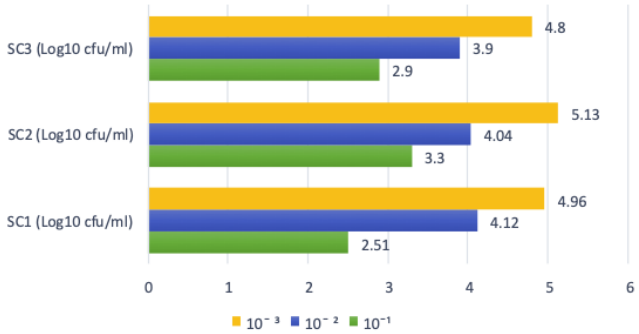


Figure 2. *Salmonella* growth in kitchen sponges. Values are in $Log^{10}$ (10 in multiplication), Cfu/ml (colony forming unit per milliliter) according to amount of dilution respectively

*Salmonella* is a bacterium that is often associated with eggs and egg-containing food. However, according to a study by [9], the highest salmonella detected are from ground chicken. Besides that, *Salmonella* has also been found on broiler chicken, pasteurized egg products and ground beef. In a study carried out by [10], 15% of sponges and dishcloths contained *Salmonella* and 20% contained *S. aureus*. The study also stated that, *Salmonella* can also be found in 60% of cellulose sponges and 86% of loofahs. The use of same cutting board while preparing raw food and uncooked food such as fruit or salad without disinfection can also transmit the pathogens to the food.

In general, results from this study indicate that the relationship between the types of food prepared by school canteen and the presence of *Salmonella* on kitchen sponge. This is because common food prepared by the school canteen contains poultry such as chicken, egg and beef, all of which contain *Salmonella*. The kitchen contact surface in food preparation such as chopping board, kitchen counter and equipment's can become the medium for the bacterial growth. Hence, the transfer of bacteria to kitchen sponge while cleaning the chopping board, knives and other kitchen equipment can become the cause of bacterial growth

*S. aureus* Growth – The highest total colony count was 3.95 $\log_{10}$ cfu/ml at dilution $10^3$ from SC3, while the lowest was from SC1 which was not detected on either dilution $10^{-2}$ and $10^{-3}$ respectively. The mean for all total colony count was 2.05 $\log_{10}$ cfu/ml.

*S. aureus* is carried in the nose of 25-35% of humans and it is a common cause of serious and life-threatening infection [11]. [12] has stated that *S. aureus* can survive for long periods once it is shed into the environment and its presence on environmental surfaces in the home has been reported in numerous studies. 30% of *S. aureus* are found on sponge and cloth. *S. aureus* have also been identified in various types of food such as meat, poultry, salads and bakery products. *S. aureus* infection will resolve within 24 to 48 hours of the onset of infection, however the effect of *S.aureus* can be severe for infants, elderly and immune-compromised patients. The concern is for the children at school that may have low immune system and digestive disorder [13].

Poor hand hygiene may contribute to high levels of *S.aureus* on the hands of food handlers [14]. The human hands have the ability to transmit pathogens from any contact surfaces or human body, to the food, especially if hands are not properly washed. Not only that, wet equipment such as sponges, dishcloths and sink drain will constantly act as reservoir that harbors and encourage the growth of potential pathogens.

### 3.2 Identification of Microbiological Found on Kitchen Cutleries

Most of the inspections carried out by health inspectors visually examined kitchen cutleries for issues such as dirt. For our study, kitchen cutleries from the school canteen are taken for microbiological evaluation. The kitchen cutleries chosen were the ones that been washed by used kitchen sponge taken for microbial testing. The dry cutleries were picked for dry swab procedure. The limitation for the test might come from uncontrolled environment since the sampling procedures were done at the school canteen itself and not in sterilized environment. However, the equipments used for the sampling were sterilized with alcohol swab.

Table 1 indicates the presence of bacteria on kitchen cutleries at the school canteen. The result shows that bacteria were present in all samples. A study on drinking water and utensils showed that *E. coli* could commonly be found on utensils [15]. The study also stated that the quality of water and cleanliness of food preparing utensil did not improved even with the usage of pipe water. The authors also noted that *E. coli* count in water and food utensil found in the treated household are not significantly lower than those found in the control household

Table 1 Presence of Bacteria in Used Kitchen Cutleries

| Food Premises | Kitchen Cutlery | Presence Of Bacteria (Yes/ No) |
|---|---|---|
| School canteen 1 | Spoon | Yes |
| | Plate | Yes |
| School canteen 2 | Spoon | Yes |
| | Plate | Yes |
| School canteen 3 | Spoon | Yes |
| | Plate | Yes |

Furthermore, a study done by [16] stated that spoon and forks had the highest rate of heterotrophic contamination. The factor that causes the high rate of heterotrophic contamination in spoon and forks is due to poor washing technique.

The presence of *E. coli* , *Salmonella* spp. and *Clostridium spp*. has become the special concern and possibly the greatest danger associated with water food processing and drinking purpose [17-19]. The presence of bacteria on kitchen utensil is an indicator of poor sanitary qualities of food utensils, ineffective washing technique as well as poor handling and storage of cleaned utensil. The presence of bacteria on kitchen utensil can be a source of foodborne disease.

### 3.3 Efficiency of Detergents Used In School Canteen

Based on the lab observations, DSC1 was more efficient at reducing the contamination of *Salmonella* with 1.9 cm diameter of inhabitation zones. *E.coli* and *S.aureus* on the other hand, recorded 1.1cm and 1.3 cm respectively. For DSC2, disc agar containing *Salmonella* showed 1.5cm diameter of inhibition while *E.coli* and *S.aureus* did not show any inhabitation. DSC3 did not show any inhabitation for all bacteria tested.

Detergent is a surfactant or a mixture of surfactants with cleaning properties in dilute solution [20]. As awareness on food hygiene preparation increases, the effectiveness of detergent used has also become a concern. The aim of detergent is to totally eradicate food poisoning microorganism in any food surfaces such a utensils, facilities or equipment's in the food processing line [21, 22]. However, based on our tests, the detergents have little only on certain types of the bacteria tested. However, based on the studies by [23, 24] detergents, if used correctly, can be highly effective against *E.coli* and *S.aureus*

## 4. CONCLUSION

Kitchen equipment such as used kitchen sponges and cutleries have become one of the important medium for the growth of pathogenic bacteria [25]. This is worrying because food handlers are not able to see the growth of bacteria on their kitchen equipment. Based on the results of this study, pathogenic bacteria are easily found on used kitchen sponges at the school canteen. Hygiene inspections by the District Health Office only covers issues such as proper storage, floor and cooked food. However, the hygiene of food contact surfaces such as kitchen sponges, dishcloths and kitchen cutleries is not included in the inspection. Students are quite susceptible to food borne illness because of their age and immune system that are still developing. Some of the students may also have an allergic reaction to certain products or food. As students also did not have many options in choosing their food at the canteen, it is important to take a proper steps in ensuring all food are safe to consume.

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