

DETERMINING OPTIMAL CLEANING FREQUENCY AND METHODS FOR WOODEN AND PLASTIC CHOPPING BOARDS

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Abstract. Contaminated chopping boards can lead to foodborne infections. In this study, we aimed to determine the optimal frequency and methods for cleaning chopping boards when the boards are for prolonged use. This study was conducted in 2 parts. The first part observed the time required for *Escherichia coli* to multiply on wooden and plastic chopping board specimens when spiked with *E. coli* at a concentration of 5 log CFU/25cm² and then incubated at 25°C in 85% relative humidity for 0, 4, 8 and 24 hours. The second part of the study consisted of determining the most effective method for cleaning chopping board specimens. We spiked the studied chopping board specimens with *E. coli* at a concentration of 8 log CFU/25cm², cleaned them using 3 dry-cleaning methods for the wooden chopping board specimens and 3 wet-cleaning methods for the plastic chopping board specimens and then culturing the chopping board specimens to determine the remaining bacterial concentrations. The results from the first part of our study showed the *E. coli* spiked studied chopping board surfaces remained stable with a bacterial concentration of about 5 log CFU/25cm² for the first 4 hours and then the bacterial concentration increased to ≥ 8 log CFU/ml by 24 hours incubation. The results from the second part of the study showed no significant difference among the studied methods for cleaning wooden chopping board surfaces but the non-significantly better method was to wipe the surface, scrape the surface and then wipe the surface again, resulting in an average bacterial reduction of 1.84 log CFU/25cm². The best method for significantly ($p < 0.05$) reducing bacteria on studied plastic chopping board surface was to scrub the surface with detergent, rinse it under running tap water, rinse it with hot water and then hang it dry, resulting in an average bacterial reduction of 5.64 log CFU/25cm². As a good hygiene practice, it is advisable to clean chopping boards frequently every four hours especially when the boards are for prolonged use. Wooden chopping boards can be cleaned by any of the studied methods but are probably better cleaned by wiping the surface, scraping the surface and then wiping the surface again. Plastic chopping boards are best cleaned by scrubbing the surface with detergent, rinsing it under running tap water, followed by rinsing with hot water and then hanging it to dry.

Keywords: wooden chopping boards, plastic chopping boards, bacterial log reduction, cleaning

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INTRODUCTION

Contaminated chopping boards can lead to foodborne infections (Carrasco *et al*, 2012; Chen *et al*, 2001; Cogan *et al*, 2002; Lubber *et al*, 2006; Ravishankar *et al*, 2010). Wooden chopping boards have been reported to be better at absorbing shock and not blunting knife blades as easily (Carpentier, 1997) while plastic chopping boards have been reported to be easier to clean (Gough and Dodd, 1998). The United States Food and Drug Administration (US FDA) Food Code does not allow the use of wood for use in chopping boards by food sellers, except hard, close-grained wood (US FDA, 2017).

Bacterial growth studies have been conducted on wooden chopping boards obtained from European wood (Abrishami *et al*, 1994; Ak *et al*, 1994a, Ak *et al*, 1994b; Dhaliwal *et al*, 1992; Miller *et al*, 1996) but not for Tembusu wood, more commonly used by food stall sellers in Singapore. Chopping board cleaning methods vary by location and culture.

In this study, we aimed to determine the best frequency and methods for cleaning wooden and plastic chopping boards to inform good hygiene practice for maintaining chopping boards for prolonged use.

MATERIALS AND METHODS

This study was conducted in 2 parts. The first part observed the time required

for *Escherichia coli* to multiply on wooden and plastic chopping board specimens when spiked with *E. coli*. The second part consisted of determining the most effective method for cleaning chopping board specimens.

Chopping board sample preparation

New and used wooden and plastic chopping boards were used for this study. The wooden chopping boards were made of Tembusu (*Fagraea fragrans*) wood and the plastic chopping boards were made of polyethylene. The new chopping boards used in this study were purchased from a major kitchenware supplier known to be patronized by food stall sellers. The used chopping boards in this study were donated from home kitchens with a history of use for at least 10 years. Each chopping board was cut into 5 cm x 5 cm pieces. The experiment was performed in duplicate.

E. coli spiking of chopping boards

The spiking of the chopping board specimens with bacteria and the bacteria recovery from the chopping block specimen surfaces were conducted using a method modified from Ak *et al* (1994b). The cutting surface of each studied chopping board specimen was sterilized by exposure to ultraviolet light for one hour in a biosafety cabinet (Ak *et al*, 1994a). The bacterial solution used to spike the chopping boards was prepared with two final concentrations. The concentration used for part 1 of the study examining bacterial

growth was 5 log CFU/25cm² and the concentration used for part 2 of the study examining the best cleaning method was 8 log CFU/25cm². The concentrations were achieved by inoculating 1 ml of solution containing *E. coli* ATCC 25922 into 49 ml LB Miller, Luria-Bertani broth (BD Difco, Franklin Lakes, NJ) and then incubating in a shaking incubator at 37°C until an optical density (OD) of 0.6 was attained at a wavelength of 600 nm. The concentrations for parts 1 and 2 of our study were determined using a hemocytometer (Figs 1 and 2). Five hundred microliters of the bacterial spike solution was spread on the cutting surface of each chopping board specimen using an L-spreader and then let set for 3 minutes before being used for the respective part of our study.

Determining the growth rate of *E. coli* on studied chopping boards

The types of chopping board samples used for part 1 of our study examining *E. coli* growth rate over time were new wooden and plastic chopping board

specimens. The spiked chopping board samples were all incubated at 25°C in 85% relative humidity and cultures were obtained at 0, 4, 8 and 24 hours after being spiked.

Chopping board cleaning methods

In part 2 we examined the efficacy of 3 dry-cleaning methods used to clean the wooden chopping board samples and three wet-cleaning methods used to clean the plastic chopping boards. The three dry-cleaning methods used for wooden chopping board samples were: Method W1) scraping the chopping board sample surface with a stainless steel chopper until a fresh board surface layer was seen; Method W2) wiping the chopping board sample surface twice with a 20 cm x 20 cm sterile, dry dishcloth; Method W3) wiping the chopping board sample surface with a 20 cm x 20 cm sterile, dry dishcloth, scraping the sample surface with a stainless-steel blade until a fresh board surface layer was seen and then wiping the surface with the same cloth.

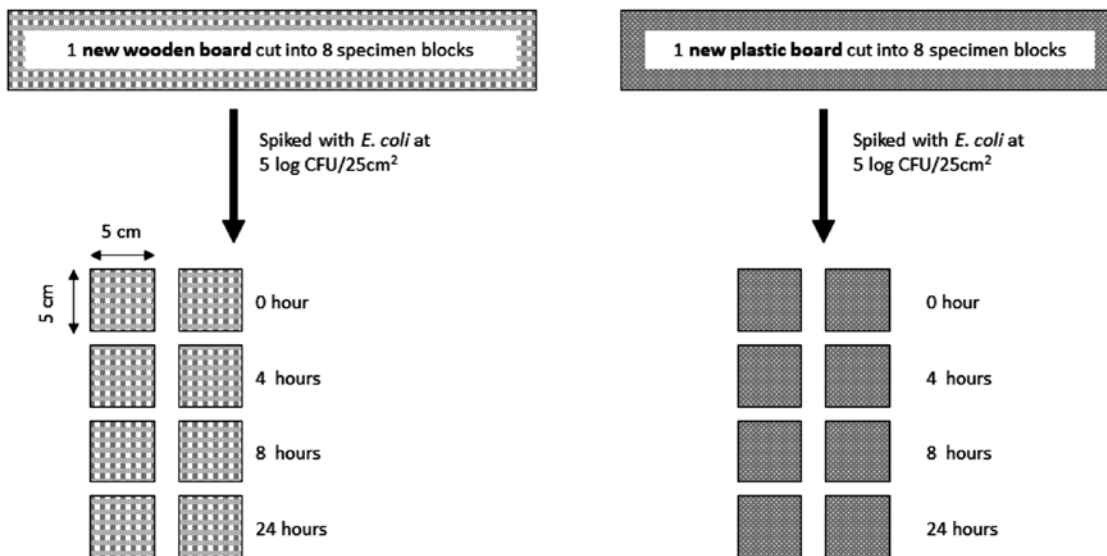


Fig 1-Evaluation of *Escherichia coli* growth rates on chopping boards by type.

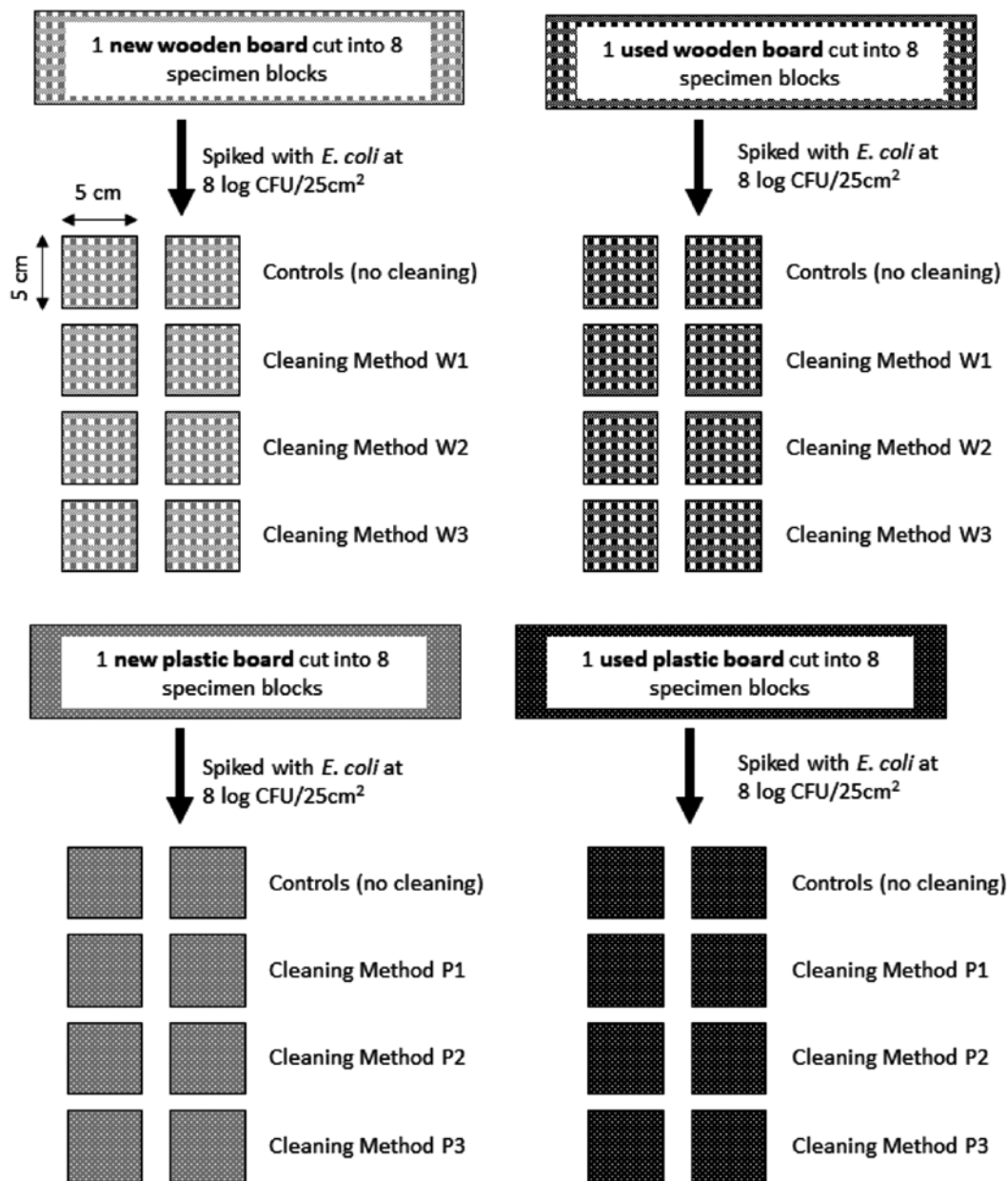


Fig 2-Evaluation of chopping board cleaning methods by board type.

The three wet-cleaning methods used for the plastic chopping board samples were: Method P1) scrubbing the chopping board sample surface 10 times with 0.2 g of household detergent (sodium linear-

alkylbenzensulfonate) using a sterile coconut brush, followed by rinsing with tap water and letting the specimen hang dry for 5 minutes; Method P2) rinsing the chopping board sample surface with

50 ml hot water and letting it hang dry for 5 minutes; Method P3) scrubbing the chopping board sample surface 10 times with 0.2 g household detergent using a sterile coconut brush, rinsing under running tap water for 1 minute, rinsing with 50 ml hot water and then letting the specimen hang dry for 5 minutes.

Control specimens were prepared to determine the level of *E. coli* on spiked wooden and plastic chopping board samples without being subjected to any cleaning methods.

Recovery of *E. coli* from the studied chopping board surfaces

For both parts 1 and 2 of the study, the following method was used to determine the presence and concentration of the spiked *E. coli* on the studied chopping board sample surface. Each chopping board sample was placed in and immersed face down in 5 ml Butterfield's Phosphate Buffer (3M™, Maplewood, MN) on a sterile petri dish and swirled periodically for 2 minutes. This was done to test for the presence of *E. coli* on the specimen surface. Serial dilutions were performed on the Butterfield's Phosphate Buffer; 100 µl of each serial dilution was then placed on a Tryptic Soy Agar (TSA) plate and the plate was incubated at 37°C for 24 hours.

Statistical analysis

The bacterial count (log CFU/25cm²) of each chopping board sample was calculated using the following formula: $\log_{10}(\text{number of colonies on TSA} \times \text{dilution factor} \times 5) / 0.1$. The dilution factor refers to the dilution of Butterfield's Phosphate Buffer (in which the chopping boards were immersed, to determine the bacterial count) from which 25-250 colonies grew, upon plating onto TSA. The reduction in bacteria due to the tested cleaning method (in log CFU/25cm²) was

calculated by subtracting the count of the specimen cleaned with the stated cleaning method from the bacterial count of the control specimen. Averages and standard errors were calculated for duplicate samples using Microsoft Excel 2016 (Microsoft, Redmond, WA). Since the data were not normally distributed, statistical differences ($p < 0.05$) in bacterial log reduction levels among cleaning methods were analysed using the Kruskal-Wallis Test. Multiple pairwise comparison of bacterial log reductions between two cleaning methods were analysed by the Mann-Whitney Test. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) software, version 14.0 (IBM, Armonk, NY).

RESULTS

Growth of *E. coli* on chopping boards

The results of part 1 of our study of the rate of *E. coli* growth on the studied chopping boards show the concentrations of *E. coli* on both the studied wooden and plastic chopping board samples remained stable at about 5 log CFU/25cm² for the first 4 hours of incubation then increased to a level of >8 log CFU/25cm² by 24 hours incubation (Fig 3).

Bacterial log reduction results

In part 2 of our study, among the three dry-cleaning methods for the wooden chopping board samples, Method W3 (wiping, scraping and wiping) resulted in a slightly greater average bacterial reduction than the other dry-cleaning methods with a bacterial reduction of 1.84 log CFU/25cm²; however, this reduction was not significant. Among the wet-cleaning methods for the plastic chopping board samples, Method P3, (scrubbing with detergent, rinsing under running tap water, rinsing with hot water and hanging dry), was significantly

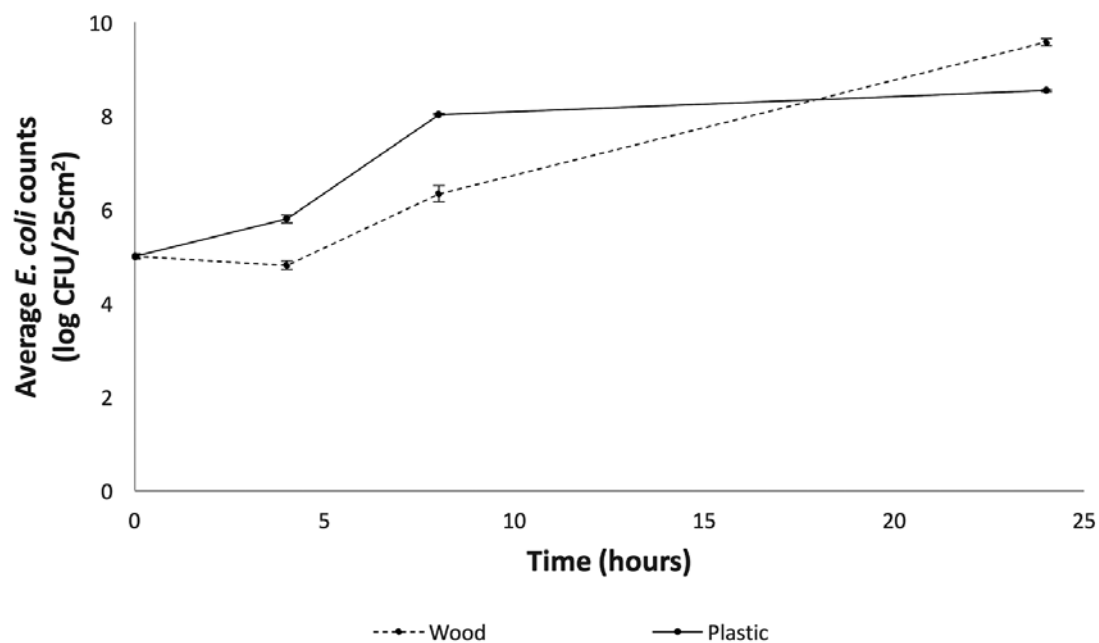


Fig 3-*Escherichia coli* by chopping board type.
(Error bars indicates 2x the standard error)

Table 1
Bacterial reduction by cleaning method per board type.

Wooden board cleaning methods	Average bacterial log reduction (log CFU/ 25cm ²)		
	New wood	Used wood	Overall
W1: Scraping	1.24	0.21	0.73
W2: Wiping	1.43	0.69	1.06
W3: Wiping, scraping and wiping	1.88	1.79	1.84
Plastic board cleaning methods	Average bacterial log reduction (log CFU/ 25cm ²)		
	New plastic	Used plastic	Overall
P1: Scrubbing with detergent, rinsing with tap water, hanging dry	2.44	1.75	2.10
P2: Rinsing with hot water, hanging dry	3.31	2.85	3.08
P3: Scrubbing with detergent, rinsing under running tap water, rinsing with hot water and hanging dry	5.77	5.52	5.64

($p < 0.05$) better than the other methods, resulting in an average bacterial reduction of 5.64 log CFU/25cm².

DISCUSSION

In part 1 of our study, the concentration of *E. coli* remained stable for the first 4 hours and then began to increase. Therefore, as a good hygiene practice, it is advisable to clean chopping boards frequently or every four hours especially when the boards are for prolonged use. A study conducted by Abrishami *et al* (1994) showed the concentration of *E. coli* remained largely stable for the first 2 hours on water-conditioned hard maple wooden cutting boards and the concentration of *E. coli* remained largely stable for the first 24 hours on plastic cutting boards moulded from clear acrylic. Though our study could not be directly compared with that of Abrishami *et al* (1994) due to differences in study parameters, such as the types of board materials, inoculum strains and concentrations, as well as bacterial recovery methods, both studies show bacteria can remain viable on chopping board surfaces for considerable periods of time and thus frequent cleaning is warranted to avoid bacterial accumulation.

In part 2 of our study, there was no significant difference among the three dry-cleaning method for wooden chopping board samples. However, Method W3 (wiping, scraping, wiping) was non-significantly better than the other methods. Though cleaning methods used in our study were different from that of Abrishami *et al* (1994), both studies showed a smaller bacterial reduction was achieved on wooden chopping boards as compared to plastic chopping boards after cleaning.

In part 2 of our study, Method P3 (scrubbing with detergent, rinsing under running tap water, rinsing with hot water and hanging dry) was significantly better than the other two studied methods, similar to the findings of another study (Ravishankar *et al*, 2010) that found mechanical scrubbing with soap and rinsing with hot water effectively cleaned heavily contaminated (5-6 log of *Salmonella enterica*) cutting boards; lettuce which was subsequently sliced on the boards were found uncontaminated with *Salmonella* spp.

A limitation of our study was that it did not involve a standardized intensity of scrubbing the chopping boards, but our actual method we believe better fits a real-life situation. Other variables we could not account for were the age of the chopping board and the previous types of food used. However, these also better reflect the reality of chopping boards used by food stall sellers in Singapore.

As a good hygiene practice, it is advisable to clean chopping boards frequently or every 4 hours especially when the boards are for prolonged use. The probable better method for cleaning wooden chopping boards is wiping, scraping and wiping and the best method for cleaning plastic chopping boards is scrubbing with detergent, rinsing under running tap water, rinsing with hot water and hanging dry.

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