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THE MICROBIOLOGY OF CLEANING AND SANITIZING A CUTTING BOARD

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The FDA model codes have always required and emphasized chemical sanitizers to make food contact surfaces safe. However, the effectiveness of chemical sanitizers is never measured in actual operations on cutting boards, and there are no standards of performance. The general government requirement is for a 100,000-to-1 reduction of pathogens on the surface. The effectiveness of sanitizers is measured on scrupulously clean pieces of stainless steel or glass in perfect sanitizer solutions in laboratory situations following AOAC procedures (AOAC, 1996).

The question, then, is, "What is the practical significance of washing cutting boards and removing bacteria?" This experiment was conducted in order to obtain practical information about the reduction of bacteria on food contact surfaces, following the standard wash-rinse-sanitize requirements in food codes. It is possible to inoculate surfaces with pathogenic bacteria, but this is not practical for validating conditions in commercial kitchens. Therefore, this study simulated actual conditions that could occur in a kitchen environment.

Experimental Procedure

Ground beef, 85%-lean was purchased at a local retail supermarket and was allowed to remain on the counter in the microbiology laboratory for 24 hours at room temperature. At the end of this time, the aerobic plate count (APC) of the ground beef was determined to be approximately 12,000,000 colony forming units (CFU) per gram.

Three food contact surfaces were evaluated in these experiments.

- A commercial hard maple cutting board, 12"x18"x1$^1/_2$", Pro-Chef, from Boos Company, Effingham, IL
- Plastic cutting board, 12"x18"x1$^1/_2$", Plasti-Tuff, from Teknor Apex, Pawtucket, RI
- Stainless steel surface in the form of the outside bottom of a stainless steel 12"x20"x4" pan, from Volwrath, Sheboygan, WI

These surfaces were marked off in squares equivalent to 8 square inches (2.8"x2.8"). To simulate contaminated surfaces, approximately 1 ounce of ground beef was smeared, using a paper towel, over the surfaces for approximately 2 minutes until there was a maximum saturation of ground beef adhering to the surfaces.

Each surface was then sampled using dacron-tipped swabs that were rinsed in letheen broth. Each swab was wetted, rubbed across the surface in one direction, rinsed in 10 ml letheen broth, rubbed in the opposite direction, and rinsed a second time. Appropriate dilutions were made and plated on aerobic count Petrifilm™. The Petrifilm™ was incubated at 35ºC for 48 hours.

In Experiment 1, the contaminated surfaces were simply wiped with home-style dish cloths that had been rinsed in 3 solutions:

- Tap water
- 1 part 5% white vinegar (H.J. Heinz, Pittsburgh, PA) combined with 4 parts water
- A 200-PPM quaternary ammonium compound sanitizer (Red Sink Sanitizer, Jefco Laboratories / SMS Technologies, Chicago, IL)

In Experiment 2, the conventional 3-step wash-rinse-sanitize procedure was used. A Viking #43 brush (Sparta Brush Company, Sparta, WI) was used to scrub the 3 surfaces in 4 gallons of detergent solution (Yellow Dishsoap, Jefco Laboratories / SMS Technologies, Chicago, IL). The surfaces were rinsed in flowing water. Then, a 200-PPM quaternary ammonium compound (Red Sink Sanitizer, Jefco Laboratories / SMS Technologies, Chicago, IL) was squirted from a bottle onto each surface.

In Experiment 3, each of the 3 surfaces was sampled before and after scrubbing under flowing, 100-110ºF water for 30 seconds using a Viking #43 scrub brush.

Results

Table 1 lists the results of Experiment 1. This experiment demonstrates the sanitizing effectiveness of wiping surfaces with a vinegar solution and with a quaternary ammonium compound solution. After contaminating each surface with ground beef that had an aerobic plate count of 12,000,000 CFU/g ($\log_{10}$ 7.08 CFU/g), the following aerobic populations of microorganisms were recovered from 8 square inches of each surface.

- 205,000 CFU ($\log_{10}$ 5.29) on the wood cutting board
- 113,500 CFU ($\log_{10}$ 5.04) on the plastic cutting board
- 40,000 CFU ($\log_{10}$ 4.49) on the stainless steel surface

Table 1. Effect of Wiping Contaminated Surfaces with Sanitizing Solution

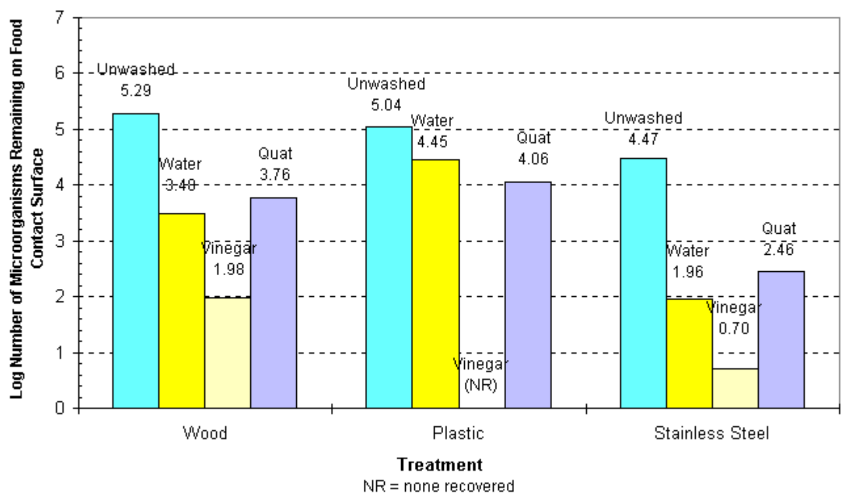
	Microorganisms (aerobic) recovered from surface (8 square inches)					
Treatment	**Wood**		**Plastic**		**Stainless Steel**	
	CFU	**$\log_{10}$**	**CFU**	**$\log_{10}$**	**CFU**	**$\log_{10}$**
Unwashed	205,000	5.29	113,500	5.04	40,000	4.47
Water wipe	3,050	3.48	28,000	4.45	120	1.96
Vinegar wipe	240	1.98	<10	0	5	0.70
Quat wipe	6,050	3.76	12,000	4.06	290	2.46

Sections of each surface were then wiped with clean, home-style dish cloths, one rinsed in water, one in vinegar, and one in a 200-PPM quaternary ammonium compound. Wiping the surface with the cloth dipped in water reduced CFU of bacteria on the wood cutting board from 205,000 to 3,050 ($\log_{10}$ 5.29 to 3.48). The water wipe on the plastic cutting board reduced the CFU from 113,500 to 28,000 ($\log_{10}$ 5.04 to 4.45). On the stainless steel surface, the water wipe reduced the CFU from 40,000 to 95 ($\log_{10}$ 4.47 to 1.96).

Wiping with vinegar reduced the CFU on the wood surface from 205,000 to 240 ($\log_{10}$ 5.29 to 1.98), on the plastic surface from 113,500 ($\log_{10}$ 5.04) to none recoverable, and on the stainless steel surface from 40,000 ($\log_{10}$ 4.47) to 5 ($\log_{10}$ 0.70).

Figure 1 is a graphical illustration of the $\log_{10}$ CFU remaining on the surfaces after each treatment.

Figure 1. Microorganisms Remaining on Food Contact Surface after Contamination with Raw Hamburger (Unwashed). and After Wiping with Water, Vinegar, and Quaternary Ammonium Solution



Wiping the surfaces with cloths soaked in quaternary ammonium solution reduced the CFU on the wood cutting board from 205,000 to 3,050 ($\log_{10}$ 5.29 to 3.76); on the plastic cutting board from113,500 to 12,000 ($\log_{10}$ 5.04 to 4.08), and on the stainless steel pan from 40,000 to 290 ($\log_{10}$ 4.47 to 2.46).

Table 2 shows the results of Experiment 2, a test of the effectiveness of the wash-rinse-sanitize process.

Table 2. Effectiveness of the Wash-Rinse-Sanitize Process

	Microorganisms (aerobic) recovered from surface (8 square inches)					
Treatment	**Wood**		**Plastic**		**Stainless Steel**	
	CFU	**$\log_{10}$**	**CFU**	**$\log_{10}$**	**CFU**	**$\log_{10}$**
Unwashed	265,000	5.41	225,000	5.35	32,000	4.50
Detergent solution	700	2.69	45	1.65	<10	0.00
Rinse in flowing water	55	1.63	10	1.00	<10	0.00
Quat wipe	135	2.13	5	0.70	<10	0.00

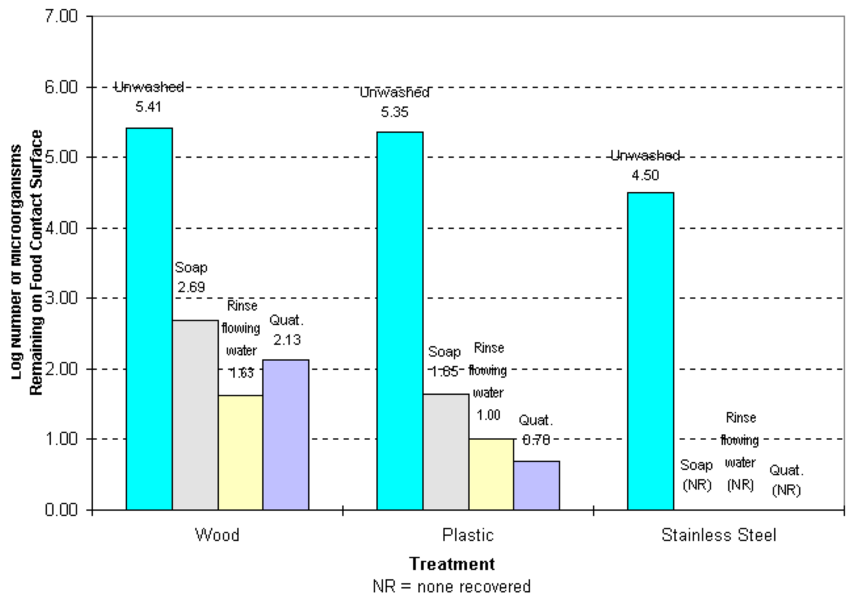
When the wood surface was washed in a sink containing 4 gallons of detergent and water, the bacteria count was reduced from 265,000 to 700 ($\log_{10}$ 5.41 to 2.69). On the plastic surface, the reduction was from 225,000 to 45 ($\log_{10}$ 5.35 to 1.65). The CFU on the stainless steel surface was reduced from 32,000 ($\log_{10}$ 4.50) to none recoverable.

Following cleaning in the detergent solution, the surfaces were rinsed with flowing water. The results were as follows. On the wood surface, the counts were reduced from 700 to 55 ($\log_{10}$ 2.69 to 1.63). Bacterial counts were reduced on the plastic surface from 45 to 10 ($\log_{10}$ 1.65 to 1.00). On the stainless steel surface, they remained at <10 or none recoverable.

When the sanitizer was applied, the counts per 8 square inches on the wood surface, after the detergent and water and rinse, increased from 55 to 135 ($\log_{10}$ 1.68 to 2.13) [a slight rise, which is within the limits of experimental variability]. On the plastic surface, the CFU decreased slightly from 10 to 5 ($\log_{10}$ 1.00 to 0.70). On the stainless steel surface, the CFU remained at <10 or none recoverable.

Figure 2 is a graphical illustration of the $\log_{10}$ CFU remaining on the surfaces after each treatment.

Figure 2. Microorganisms Remaining on Food Contact Surface after Contamination with Raw Hamburger (Unwashed), and After Scrubbing with Soap and Water, Rinsing with Flowing Water, and Sanitizing with a Quaternary Ammonium Solution



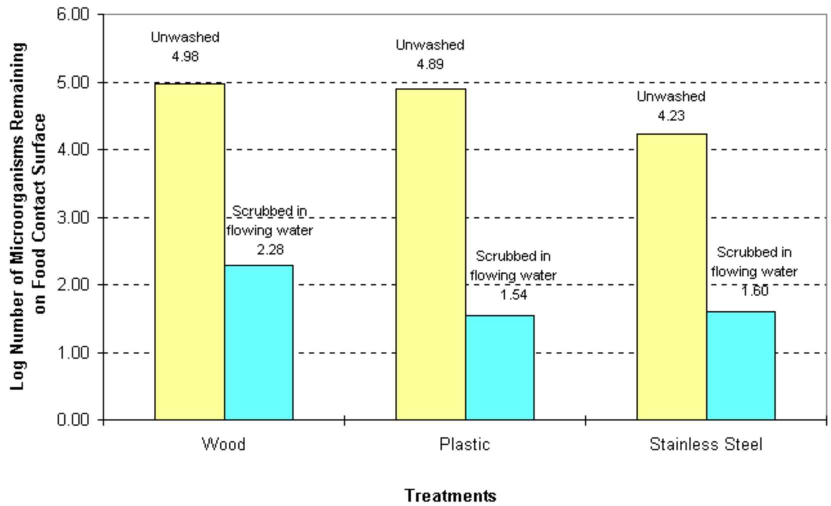
In Experiment 3 (*Table 3*), the effectiveness of scrubbing each of the surfaces in flowing water was tested. Again, the CFU per 8 square inches on the wood cutting board count decreased from 95,000 to 205 ($\log_{10}$ 4.98 to 2.28). The CFU on the plastic cutting board decreased from 78,000 to 40 ($\log_{10}$ 4.89 to 1.54). The CFU on stainless steel surface was reduced from 17,500 to 47 ($\log_{10}$ 4.23 to 1.60 CFU) per 8 square inches of surface.

Table 3. Effect of Scrubbing Surfaces in Flowing Water

	Microorganisms (aerobic) recovered from surface (8 square inches)					
Treatment	**Wood**		**Plastic**		**Stainless Steel**	
	CFU	**$\log_{10}$**	**CFU**	**$\log_{10}$**	**CFU**	**$\log_{10}$**
Unwashed	95,000	4.98	78,000	4.89	17,500	4.23
Scrubbed in flowing water	205	2.28	40	1.54	47	1.60

Figure 3 is a graphical illustration of the log_{10} CFU remaining on the surfaces after scrubbing surfaces in flowing water.

Figure 3. Microorganisms Remaining on Food Contact Surface after Contamination with Raw Hamburger (Unwashed) and After Scrubbing in Flowing Water



Discussion

Experiment 1 demonstrated that rinsing a cutting board with a solution of 1 part 5% vinegar to 4 parts water was a more effective sanitizer than using a quaternary ammonium compound solution for removing aerobic bacteria from a food contact surface. Assuming that there are not more than 1,000 *Salmonella* per 8 square inches (which is a high estimate), vinegar would be effective in reducing the numbers of this pathogen on surfaces to a safe level with no other treatment. Using only water and using a quaternary ammonium compound solution were quite similar in their sanitizing performance, but not as effective as the vinegar solution. The data indicate that a lower population of bacteria was present on the stainless steel surface. This is an indication that bacteria do not adhere to stainless steel as easily as to plastic and wood surfaces. The data also indicate that bacterial contamination is much easier removed from a stainless steel surface.

In Experiment 2, it is evident that the rinsing-after-washing process does little to reduce bacterial counts, even though the surfaces were rinsed with flowing water. Applying the quaternary ammonium compound solution had essentially no value. This has been apparent in practical sampling of food contact surfaces in retail food operations. The data indicate that washing surfaces with the detergent solution was the critical step for removing aerobic bacterial contamination from food contact surfaces.

Experiment 3 shows the practical value of the pre-wash, rinse, and scrub before putting the cutting board into the detergent-and-water sink. Simply scrubbing the cutting board in flowing water, without the use of a detergent reduced the bacteria enough that even if there were a heavy load of *Salmonella*, *Campylobacter jejuni*, or other pathogens, there would be so few pathogens remaining that the surface would be considered safe. Putting a cutting board containing pathogens into a clean detergent solution in a sink merely contaminates the wash water.

Conclusions

The FDA code and health departments across the United States have emphasized the use of sanitizing chemicals as the critical point for making food contact surfaces safe. These data show that this assumption is not always accurate. Wiping the surface with a clean cloth soaked in vinegar appears to be a very effective sanitizer, based on the data. Simply rinsing and scrubbing a dirty surface with flowing water seems to be more effective than cleaning and sanitizing food contact surfaces with a cloth dipped in a quaternary ammonium compound solution. It is also known that when a quaternary ammonium compound solution becomes dirty in an open bucket into which dirty cloths are dipped, the solution becomes susceptible to degradation by filth, dirt, and other debris. As a result, the solution does not remain at its beginning strength over a period of 2 hours that the solution is used. The quaternary ammonium compound solution used in this experiment was dispensed from a squirt bottle to maintain its effectiveness and prevent degradation.

This simple experiment demonstrates that semi-spoiled ground beef, a simple swab, and Petrifilm™; can be used to validate that a surface has received a 100,000-to-1 bacterial removal treatment.

Recommendations

It is recommended that action be taken to get vinegar approved as a food contact surface sanitizing agent, especially for the home. The FDA should revise the model code to require a scrub brush rinse in the first compartment of a three-compartment sink, then a detergent-and-water wash in the second sink followed by a rinse in the third sink. The sanitizer, if desired, should be applied from a squirt bottle.

In terms of significant bacterial reduction, only two sinks are needed--the pre-wash rinse sink and the wash sink. However, a rinse following the detergent-and-water wash is necessary to remove the detergent solution. If a surface is wiped with a clean cloth saturated in vinegar after it is taken out of the wash sink, the surface will have received an adequate reduction of potentially pathogenic bacteria.

Reference:

AOAC. 1996. Official methods of analysis of AOAC International. Chapter 6. Disinfectants. AOAC. Gaithersburg, MD.