MICROBIOLOGY OF CUTTING BOARDS FOR FOOD SAFETY

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Food safety publications often recommend that plastic--rather than wood--cutting boards be used, for greater safety in homes, restaurants, butcher shops, and food processing. The concern is that disease-causing bacteria from meat or poultry will soak into the wood board and later contaminate other foods that are cut on the same surface. We have found no earlier research that supports this concern.

The objectives of our study were to learn about bacterial contamination of wood cutting boards and to find convenient means of decontaminating the wood so it would be almost as safe as plastic. But that's *not* what happened.

RESEARCH SUMMARY

Wood and plastic cutting boards were compared for their sanitary characteristics (Table 1). For experimental precision, new and used boards were cut into units having a surface area of 25 cm^2 (about 4 sq.in.). The surface of each unit was contaminated with the test bacterium (*Escherichia coli*) in 0.3 or 0.5 ml of nutrient broth. After contamination, *E. coli* was recovered from the block surface by rinsing with nutrient broth: a) immediately, b) after 3 min., and c) after ca. 12 hr. Recoveries from wooden blocks were generally less than those from plastic blocks; the differences increased with holding time. The wood blocks absorbed the inoculum completely within 3 min. Many of the blocks have been used repeatedly (some >30 times); before reuse, these were treated with hot water and disinfectant, or with a hot or boiling solution of chlorine bleach if the contaminant was a pathogen.

Table 1. Types of cutting boards tested in this study

Group	Type (species or polymer)
WOOD	Hard maple--face grain & end grain American black walnut, ash, basswood, beech, birch, black cherry, butternut, oak
POLYMER	Polyacrylic, polyethylene, polypropylene, polystyrene, hard rubber

Wood cutting boards came both from manufacturers interested in the project and from home kitchens. Recovery of the test microorganism was studied as a function of wood species, mineral oil coating, smoothing with sandpaper, and presence of knife cuts on the surface. There were no significant differences among wood species or treatments ($p > 0.05$).

Polyacrylic, polyethylene, polypropylene, and polystyrene cutting boards were supplied by companies. In addition, one used plastic board (probably polyethylene) was obtained from the meat department of a grocery store, one (polyethylene) from a home kitchen, and one (hard rubber) from the Muscle Biology Laboratory of UW-Madison. No significant differences were found among these five or six varieties of cutting boards with respect to the recovery of *E. coli*, whether they were new or used.

In overnight studies, blocks were kept at 4°C (39°F) and at room temperature, under high or normal (room) humidity conditions. *E. coli* grew on plastic blocks kept at room temperature but only survived (without growth) at 4°C, at both humidity levels. Once again, no bacteria were recovered from wood blocks under these conditions.

To measure the bacteria-absorbing and holding capacity of wood under extreme conditions, high levels of inoculum (more than a million/ml) were applied 3 days in a row, with overnight incubation at room temperature under high humidity conditions and with no attempt to clean the contaminated surfaces. Although some bacteria were recovered in this set of experiments, the percent recovery was extremely low; but when the same experiment was repeated with plastic blocks, growth of the test microorganism was observed under these conditions.

To see if the early results were strain-dependent, we used a second, field-isolated strain of the *E. coli*. This second strain was more persistent under some conditions, but the results in general were not affected significantly. Further experiments were performed with *Listeria innocua* and then with the three selected pathogenic species (Table 2). The strain of *L. monocytogenes*, Scott A, is notoriously resistant to environmental rigors; it was slightly more persistent than the other bacteria in these experiments.

Clearly, the interaction of the bacteria with the wood posed an important question. It seemed possible that the bacteria were somehow injured and unable to express themselves by the spread plating method that was used in enumeration. However, no injured bacteria were detected in broth medium by the Most Probable Number technique. We also performed tests to see if there was an inhibitory compound in wood that prevented bacterial growth. If such a substance exists, we were unable to extract it from the wood for analysis. Recent experiments with powders of various

Table 2. Bacteria used in this study

Category	Species	Illness caused
Models	*Escherichia coli* (2 strains)	None
	Listeria innocua	None
Disease agents	*Escherichia coli* O157:H7	Bloody diarrhea, hemolytic uremic syndrome, etc.
	Listeria monocytogenes	"Flu-like illness," stillbirths, severe illness in newborns & immunoimpaired persons
	Salmonella typhimurium	Diarrhea, etc., sometimes long-term arthritis

species of wood suggest that the bacteria remain alive for periods of time in the wood pores, but cannot emerge from the surface to contaminate anything else.

Raw chicken materials were used as alternatives to laboratory broths in some contamination experiments. First, raw chicken juice collected from whole retail chicken packages was applied on block surfaces, using its intrinsic bacteria as contaminant. In this case, there was a difference between blocks from new and used cutting boards--there was about a sixteen-fold increase (ca. four bacterial generations) on new wood surfaces, whereas nothing was recovered from the used ones. However, new and used plastic blocks gave quite similar results: there was about a 5- to 6-log increase in number (multiplication by a factor of 100 thousand to a million) of bacteria after overnight holding.

Later, filter-sterilized chicken juice was inoculated with high levels of *E. coli* O157:H7, *Listeria innocua*, or *S. typhimurium* and used to contaminate block surfaces. Results in this case were similar to those when nutrient broth had been used in applying the bacteria (Table 3).

In further trials, chicken fat was applied on block surfaces before the contamination step (after chicken fat application, surfaces were sterilized with ultraviolet light). The chicken fat made all the block surfaces very hydrophobic, and some of the wood blocks did not absorb the contaminant completely during the overnight holding period, which was quite unusual. The recovery results were different in this case; they varied depending on the absorption of the contaminant by the block. If there was a

Table 3. Overnight (room temperature) persistence of bacteria applied to cutting boards in filter-sterilized chicken juice

Microorganism	Level applied*	Board	Level recovered*
E. coli O157:H7	4.4×10^6	Plastic, #1	4.3×10^8
		#2	3.1×10^8
		Wood, #1	2.4×10^3
		#2	4.6×10^2
L. innocua	5.2×10^6	Plastic, #1	7.3×10^7
		#2	9.0×10^7
		Wood, #1	9.9×10^4
		#2	4.7×10^3
S. typhimurium	1.4×10^7	Plastic, #1	3.2×10^8
		#2	3.0×10^8
		Wood, #1	9.0×10^4
		#2	4.7×10^3

* Colony-forming units per block

visible amount of contaminant on the surface after overnight holding, the percent recovery was quite high, in some cases greater than 100 percent of what had been inoculated. But if the block surfaces were dry, there was at least a 3-log (99.9%) reduction in the bacterial load. These results were not dependent on wood variety; the same variety of wood gave different results, because of the difference in absorption, depending on how thoroughly the surface was coated with chicken fat. Once again, the bacteria multiplied on all of the plastic block surfaces under the same test conditions.

These results showed the importance of not letting fatty food residues accumulate on cutting boards--especially wood boards. Other cleaning experiments have tested the effect of a hot (57°C, ca. 137°F) solution of liquid dish detergent, followed by a hot rinse, on *E. coli* O157:H7 on board surfaces. Wood surfaces washed 3 min. after contamination yielded essentially no bacteria, whereas residual bacteria were found on the surfaces of both new and used plastic boards. When the level of contamination was high, more bacteria were found on used than new plastic boards.

SUMMARY

Both nutrient broth and chicken juice are rapidly absorbed by wood cutting boards. If these fluids contain levels of bacteria likely to come from raw meat or poultry, the bacteria are carried into the wood and cannot be recovered within 3 to 10 min. If the board surface is thoroughly coated with chicken fat or if *millions* of bacteria are applied, some of these bacteria may be recovered even after 12 hr. at room temperature (and high

humidity). Cleaning with hot water and detergent generally removes these bacteria. Results are generally independent of bacterial species, wood species, and whether the wood is new or used.

New plastic cutting surfaces seem easy to clean, but sometimes require more rigorous cleansers than hot water and dish detergent to remove all disease bacteria. Used plastic boards with extensive knife scars are very difficult to clean by hand, although bleach solutions (or perhaps a home dishwasher) will apparently disinfect these surfaces. These results were common to the four polymers tested, as well as hard rubber.

FUTURE

Further research is needed to explain the antimicrobial action of the wood. Even if the bacteria are only held physically within the wood pores, this phenomenon may prevent cross-contamination of foods cut on wood surfaces. Still, the true fate of the bacteria in wood must be determined before general recommendations regarding wooden food-contact surfaces can be made.

Further research is also needed to devise adequate cleaning methods for plastic surfaces. It may be that badly knife-scarred plastic boards must either be resurfaced or discarded, but even new plastic boards seem somewhat more difficult than wood to rid of bacterial disease agents.

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7 February 1993