

Scientists Seek To Sanitize Fruits and Vegetables

Agricultural advances, improved distribution, and increased imports have made it possible for people in every state to enjoy fresh fruits and vegetables year-round. Americans know the health benefits of a diet high in produce and are taking advantage of this increased availability and variety.

But occasionally, raw produce can become contaminated with disease-causing organisms such as *Escherichia coli* O157:H7, *Salmonella*, or *Listeria monocytogenes*. Although these instances are relatively uncommon, media reports and public awareness in the last few years have increased because scientists and public health agencies have become better at detecting, reporting, and determining causes of foodborne illness.

When produce is being grown, harvested, packed, and shipped, it can pick up dust, soil, microorganisms, or chemical contaminants. Consumers should wash fruits and vegetables to remove those substances from surfaces.

A Clean Break

Whatever the source of contamination, more than one solution may be needed. One area of concern is that conventional washing methods remove or kill only between 90 and 99 percent of bacteria attached to the surfaces of produce. Scientists at the Eastern Regional Research Center (ERRC) in Wyndmoor, Pennsylvania, are searching for practical ways to overcome these current limitations.

The scientists are conducting experiments on commercial-type produce washing and sanitizing equipment to reduce bacterial populations on fresh and minimally processed fruits and vegetables. The tests use produce artificially contaminated with harmless bacteria similar in behavior to disease-causing organisms. This research is being conducted in a unique BSL-2 (short for biosafety level 2) pilot plant at the ERRC, says Gerald M. Sapers, a food



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Engineering technician Andrew Cuthbert (foreground) gathers apples exiting a flatbed brush washer within a containment chamber in ERRC's new biosafety level-2 pilot plant. Behind him, mechanical engineer Joseph Sites (middle) and food microbiologist Bassam Annous operate the equipment.

technologist with ERRC's Food Safety Interventions Research Unit.

Future studies will be carried out on produce contaminated with actual disease-causing organisms within a containment structure equipped with its own steam decontamination system. A small-scale prototype was designed, built, and validated by a team of scientists and engineers from Pennsylvania State University and ERRC.

"Early tests with the prototype containment system have been very successful, and installation of a full-scale unit at ERRC is nearing completion," Sapers says.

Paul Walker, a professor of agricultural and biological engineering at Penn State, came to ERRC on a 15-month sabbatical to design, build, and evaluate research-grade produce-washing equipment for the BSL-2 pilot plant as part of a joint venture between Penn State and

ARS, says Sapers. Walker oversaw the design and construction of the prototype and full-scale containment systems as well as the newly designed, commercial-scale washing equipment the lab received from Penn State. This equipment is operated by computer and permits precise control of all experimental variables. Joseph Sites, an ERRC mechanical engineer, manages the pilot plant, designs equipment, and conducts experiments.

Sapers and food microbiologist Bassam Annous are developing new washing and sanitizing treatments in the laboratory and then testing them in the pilot plant. Current trials are performed primarily with apples and cantaloupes, using nonpathogenic surrogates for human pathogens.

Denise Riordan, a former research associate, and Annous compared non-pathogenic strains of *E. coli* with harmful



strains to find surrogates with similar traits.

ARS uses pilot plant programs to serve as a bridge between invention and commercialization. Industries form partnerships with ARS scientists to further evaluate research that shows promise in the laboratory. Effective technology can then be transferred to produce packing and processing industries.

Sapers says that the one-of-a-kind equipment developed in this program allows improvements in conventional methods as well as novel approaches.

“The equipment must be suitable for use in a commercial produce packing or processing facility,” he explains.

One of the major problems that the ERRC team is addressing is the ability of bacteria to attach firmly to produce surfaces, often in inaccessible locations, and survive conventional washing and sanitizing methods.

Packinghouses use chlorine and other sanitizers to reduce microbe levels, but conventional sanitizers are not able to penetrate skin crevices, creases, or pockets to destroy pathogens very effectively. The trick is to find an agent that will reach the pathogens without damaging the appearance and texture of the product.

Is the Solution in the Solution?

Scientists at ERRC have confirmed the limited capabilities of conventional washing methods, and are now looking for methods that increase the safety of produce while keeping the sensory qualities consumers expect in their fruits and vegetables. Their results with experimental sanitizing treatments have been mixed.

Washing apples in a brush washer, even when the apples were sprayed with very hot water, was found to be ineffective. Sapers says that total immersion in a sanitizing solution is superior to brush washing. However, he cautions that improper use of this “dump tank” method for washing can lead to cross-contamination of the submerged produce.

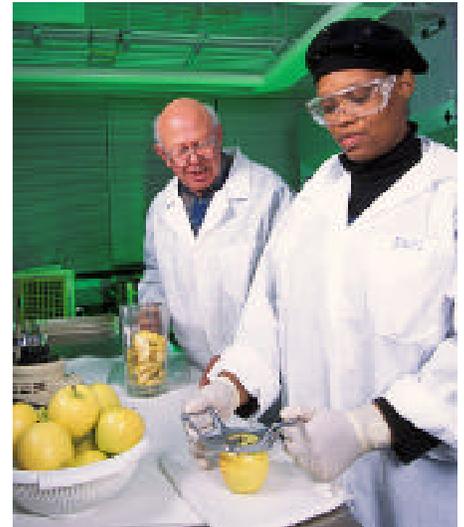
Experimental hydrogen peroxide and hot water treatments were applied to apples in a dip tank at different temperatures. Temperatures exceeding 60°C could not be used without causing discoloration. While such treatments were able to eliminate up to 99.9 percent of the bacteria, they still did not achieve the total kill (99.999 percent) desired by the Food and Drug Administration.

Sapers says other experimental methods being studied involve steam treatments or application of sanitizer solutions under vacuum—for better surface penetration.

“This would be a new approach for commercial facilities,” he said. “One challenge for researchers is to find ways to keep the speed of the processing line up to par, even when new sanitizing operations have been incorporated into the process.”

Another method they are trying in Wyndmoor involves treating apples and other produce with acetic acid and hydrogen peroxide vapors. Sapers said there were large population reductions in

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Food technologist Gerald Sapers (left) and technician Donyel Jones evaluate apples after an antimicrobial wash treatment.

inoculated apples with some vapor treatments but also some product discoloration. Work in this area is continuing.

Yet another approach involves the use of an abrasive paste to grind pathogens off produce surfaces while being careful not to bruise or puncture the product.

The pilot plant program will become fully operational when the larger containment structure is in place, permitting the scientists to experiment with real pathogens.—By **Jim Core**, ARS.

This research is part of Food Safety (Animal and Plant Products), an ARS National Program (#108) described on the World Wide Web at <http://www.nps.ars.usda.gov>.

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