The Science of Food Safety

By Rebekah L. Fraser

High-tech solutions to improve handling and prevent contamination

APPLIED TECHNOLOGY

Spinach, sprouts, peppers… E. coli, salmonella, listeria... In the last decade, cases of foodborne illness have crossed the nation and globe, inciting fear and confusion among consumers, and wreaking havoc on the produce industry. Despite deep partisan division on other matters, the U.S. Congress recently united to approve sweeping changes with the Food Safety Modernization Act.

Although this 'comprehensive overhaul' is aimed at every aspect of food production to prevent contamination and illness, its effectiveness or success may not be realized for some time (even if Congress follows through and fully funds the Act, which is no guarantee). Yet instead of waiting, many industry firms are taking matters into their own hands with new measures that will not only enhance food safety but add value. In recent years several methods have emerged as viable techniques; with numerous U.S. Department of Agriculture (USDA)-funded research projects in progress, the coming years are sure to bring additional options for increasing food safety.

Irradiation

Among the more controversial treatments for produce is irradiation, though the process has garnered considerable support in recent years from food safety advocates. Since washing produce doesn't remove all organisms and there have been incidents of wash water contamination at packaging facilities, irradiation can reduce the risks of recalls for tainted food products, as well as the resulting foodborne illnesses, deaths, and lawsuits.

Dr. Harry Hull, former state epidemiologist for the Minnesota Department of Health, spent most of his career working in infectious disease control. "For the health of our children, we need to be irradiating a lot of food," he insists. "It's really incumbent upon producers to work with food irradiators to get additional facilities online and start irradiating their products."

Although "irradiation" sounds futuristic, the first patent for its use on food was issued in the United Kingdom in 1906. Irradiation exposes food to a carefully measured level of ionizing radiation through an x-ray, gamma ray, or electron beam (e-beam). Ionizing radiation damages the nucleic acids of the insects or pathogens, so they have no chance of multiplying and causing an infection if a product is consumed.

Advocates point to hundreds of studies showing the technology to be safe while causing no change in appearance, nor any loss of nutrients or taste. Although low doses have been approved for use by the Food and Drug Administration (FDA), so far, it is only being used on spinach and iceberg lettuce, and even there on a limited basis.

In addition to preventing contamination, extra low

Key Elements

Use of cutting edge food safety techniques can help eliminate the threat of contamination and prevent foodborne illnesses:

- though still somewhat controversial, irradiation holds promise with certain products
- various new rinses use antimicrobials instead of chlorine
- ultraviolet light is a chemical-free alternative
- high pressure processing can be especially effective for processed commodities.

To learn more about each key element, look for the symbols throughout the article.

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doses (under one kilogray) can also be used to slow the ripening process and increase shelf-life, adding value to various commodities. For example, irradiated papaya can be left on the tree longer to ripen and develop full flavor before shipping, rather harvesting immature fruit and using hot rooms for ripening.

Tubac, AZ-based Ciruli Brothers, LLC has relied on hot water quarantine immersion for imported mangoes and other tropical products for more than twenty years. Though the company has considered irradiation, it found internal damage to irradiated fruit on more than one occasion. While Chris Ciruli concedes irradiation is probably part of the future, he says the expense of adopting a new system (which can run from $6 to $8 million) and explaining it to customers does not present enough of a benefit to make the change.

Perception remains a key issue. In an article about irradiation in the wake of Germany's E. coli outbreak, professor Patrick Wall, former chairman for the European Food Safety Authority, told *Food Production Daily*, "Rather than thinking of [irradiation] as a first cousin of their microwave, many consumers think of Chernobyl."

Carl Blackburn, a food irradiation specialist with the International Atomic Energy Association, commented, "The issue of [irradiation] labeling may persist, but hopefully people will begin to view the technology favorably, or at least understand that it doesn't mean the food is radioactive, it means the food has been zapped."

Rinses

For years, the industry standard has been to rinse certain produce with chlorinated water. Some companies, like Dallas-based Combs Produce, rely on a chlorined water spray to sanitize bulk tomatoes before shipping. The primary difference between straight chlorine rinses and some of the newer rinses on the market is the use of alternative antimicrobials.

Dr. Robert Buchanan, director at the University of Maryland Center for Food Safety & Security Systems, reports most rinses provide a 90 to 99 percent reduction. "The primary role of antimicrobial rinses is to wash bacteria off contaminated produce while preventing the bacteria from attaching to other fruits or vegetables," he says. While this provides a significant reduction in risk, Buchanan stresses it is not "an absolute elimination of the hazard."

Connie Bordanaro, of Freemont, CA-based PurFresh Inc. says her company's solution generates ozone from ambient air and dissolves it into processing and rinse water applications to create a disinfectant that works 3,000 times faster than chlorine. Surface and waterborne pathogens, including E. coli, *Cryptosporidium* and giardia cysts, are destroyed by the ozone's chemical structure which then reverts to pure oxygen, eliminating the need to store chemicals or dispose of wastewater. Bordanaro claims most workers prefer ozone over chlorine, as the water is clean and they aren't forced to inhale chemicals.

The recently released Fresh Rinse, by Fresh Express, is a wash made from a peroxyacetic acid, an organic peroxide, and lactic acid. Though parent company Chiquita made many claims about Fresh Rinse, little independent testing has been reported.

Another relatively new rinse is T-128, currently produced and marketed as SmartWash by New Leaf Food Safety Solutions in Salinas, CA. Pat Millner, research microbiologist at the USDA's Agricultural Research Service in Beltsville, MD, has been working with colleagues to determine the efficacy of SmartWash and its ability to reduce harmful organisms, primarily on tomatoes and leafy greens.

SmartWash is designed to stabilize the chlorine in a rinse, to last longer in wash treatments. When lettuce is cut and washed for bagged salads, it is usually put into water with a higher level of free chlorine, which is rapidly consumed and depleted by the high organic load (i.e., the organic matter in the water). The industry standard is to measure chlorine levels every 30 minutes; adding SmartWash is supposed to help preserve these levels.

Rinses, like irradiation, can also be used to extend the shelf life of certain products, though the quality level of produce entering a processing center affects its shelf life as much or more than a rinse. These properties and more are the subject ongoing research studies.

Ultraviolet Light

Like irradiation, ultraviolet (UV) light is a chemical-free method of disinfection used in other industries for years, but has only recently gained footing in food safety. If Dr. Buchanan is correct, UV light may have a strong future in the produce industry as a targeted application for food safety.

As produce passes through a properly designed UV tunnel, the UV light breaks the DNA structure of contaminants like E. coli, salmonella, and listeria, so it can no longer reproduce and dies. With proper design, UV light equipment will not heat the produce—though light requirements can vary significantly depending upon the commodity and where it was grown, as pathogens often flourish in one part of the country over another.

"We're taking a light form and condensing it down to a particular wavelength to break down a contaminant almost instantaneously," says Troy Smith, president of Houston, TX-based Radiant Industrial Solutions, Inc. "We have to calculate how much light to put into a particular design; a design application considers how fast the produce is moving from point A to point B," he explains.

The amount of UV light depends on scientific data and customer specifications; a poorly designed system can result in produce shadowing or poor penetration, where not all surfaces are reached by the UV light. The opposite can also occur, with an excess of UV that can bleach produce. If the conveyor belt moves products under the lamp too slowly, the UV light can distort the product's taste or dry it out. But if the technology is properly measured and controlled, it can be very effective in destroying contaminants and preventing foodborne illness.

For years, water treatment plants used UV to clean without chlorine and chemicals, yet in produce disinfection, the technology is just making headway. And while other food safety measures claim to add value by extending shelf life, UV does have an additional benefit—vitamin enhancement. Research has shown UV-B light enhances Vitamin D in mushrooms, while the USDA found applications of UV-C light increased antioxidant activity and slowed decay in strawberries. Other testing continues on carrots exposed to UV-B for nutrient and antioxidant enhancement.

The cost of a UV line ranges from $15,000 to $25,000. Once a system is properly installed, it controls itself. Upfront costs cover custom equipment design; even ten years down the road a properly designed and installed UV light system requires only an annual light bulb change.

Ultraviolet-Plus

Another method combines UV light with a unique water application process to increase food safety and add value. Fresh Appeal USA, Inc.'s Fresh Produce System is a trademarked, patented disinfection solution that works on a wide range of produce to protect against bacetrial infections like E. coli, listeria, and salmonella while extending shelf life and preserving the appearance, flavor, and vitamin content of the commodity.

Steve Lacasse, executive vice president of the NH-based Fresh Appeal, says systems are tailored to each customer's requirements and can be integrated into an existing processing line or set up as a stand-alone process line. The system utilizes three main steps: a turbulated disinfection wash with exposure to the UV-C

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source, followed by two additional controlled temperature washes.

The cost of a license to use the technology is determined by many factors, including the number and types of produce to be processed, annual volume, and the amount of customization required. The technology is not commodity specific and best applied during preparation for packaging.

High Pressure Processing

High pressure processing (HPP) is recognized by various international regulatory bodies as an effective method to achieve at least a 5-log pathogen reduction (i.e., 100,000 times fewer pathogens) in fruits, juices, and other products. Inactivation of foodborne bacterial and parasitic pathogens has been well demonstrated in the laboratory for most food categories.

Saginaw, TX-based Fresherized Foods, makers of Wholly Guacamole and Wholly Salsa, uses HPP exclusively because of its effectiveness in eliminating pathogenic contamination. Their high-pressure pasteurization process uses 85,000-plus pounds per square inch of pressure (five times more than at the deepest part of the ocean) to seal in flavor without the use of preservatives or chemicals.

Steve Parnell, president of Fresherized Foods, says many manufacturers of guacamole and salsa use the technology because it doesn't use heat in the pasteurization process, which can affect both the flavor and texture of avocados. Instead, HPP preserves the fruit while disrupting pathogens.

Dr. Errol Raghubeer, vice president of microbiology and food technology at Kent, Washington's AVURE Technologies (maker of the HPP system used to protect Fresherized Foods' products), says the process can also be used on fresh-cut fruit, bottled juices, and wet salads. "The process has no significant effects on the organoleptic and nutritional properties of foods. Foods retain vitamins, natural bioactive components, and flavor," he states. In addition, HPP allows food processors to extend the shelf life and quality of their products for retailers and consumers. "HPP uses the natural hydrostatic energy generated by the compression of potable water to induce biochemical changes in microorganisms."

The Future of Food Safety

Numerous USDA grants support research into food safety measures and equipment, including a new optic scanning system developed by Agriculture Research Service biophysicist Moon Kim, to scrutinize produce while still at the packinghouse.

Though the scanning system has only been tested on apples so far, it can discern evidence of certain kinds of defects or contaminants. Since cuts and nicks can provide an opportunity for bacteria, and residue can indicate the presence of bacteria, the optical scanning system may become a major breakthrough in promoting food safety. Kim and his partners have already received a patent for their automated system and expect to make the technology available to the marketplace in a few years.

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