HACCP Guidelines for Fresh-Cut Processing

By Lou Cooperhouse and James Bail

America's food is among the safest in the world. Nevertheless, in a paper published in 1999 by scientists at the U.S. Centers for Disease Control and Prevention (CDC), it was reported that approximately 76 million illnesses, 325,000 hospitalizations and 5,000 deaths are due to foodborne disease in this country each year. More than 200 known diseases are transmitted through foods, originating from viruses, bacteria, parasites, toxins, metals and prions. The symptoms of foodborne illness range from mild gastroenteritis to life-threatening neurological, hepatic and renal syndromes. Since no food company wants to make its customers sick, the industry has developed several strategies aimed at reducing potential contamination of products.

One principal food safety standard that has emerged as a powerful tool to help mitigate the incidence of foodborne illness is the Hazard Analysis and Critical Control Points (HACCP) model. This systematic approach to food safety focuses on the evaluation and control of foodborne hazards. It is a powerful and practical concept that can be applied at every link in the supply chain—from farm to fork. In the case of foodborne illness causing pathogens, such as *E. coli* O157:H7, *Salmonella* and *Listeria monocytogenes,* recent food regulatory agency reports have credited the implementation of HACCP in regulated industries as a key factor in reductions in the incidence of microbial contamination of food samples. *Listeria monocytogenes*, for example, is a widespread bacterium in the environment, can grow in cold temperature environments such as home refrigerators and food processing plants, and can cause a deadly disease (listeriosis) in at-risk populations that include pregnant women, immunocompromised individuals and the elderly. In October 2003, the U.S. Department of Agriculture's Food Safety and Inspection Service (USDA FSIS) released new data showing a one-year, 25 percent drop in the occurrence of positive *Listeria monocytogenes* in food samples, and a 70 percent decline compared with years prior to the implementation of HACCP in the meat and poultry industries.

The use of HACCP is a regulatory requirement for the seafood, meat, poultry and juice industries, and the approach has been voluntarily and widely adopted by many other segments of the food manufacturing industry. Developing a HACCP plan demands broad knowledge of the food, its intended use and hazardous constituents. HACCP development also requires an exquisite understanding of the processes used in the production, packaging, storage and distribution of the food. Moreover, HACCP development demands knowledge of the manufacturing process capability with respect to preventing the production of foods that contain dangerous biological, chemical or physical defects.

What is HACCP?

HACCP was developed about 30 years ago, initially for the National Aeronautics and Space Administration (NASA) program. Traditionally, industry and regulatory agencies depended on spot checks of manufacturing facilities and random sampling of final products to ensure safe food. This approach, however, tended to be reactive rather than preventive. With the advent of HACCP, the U.S. Food and Drug Administration (FDA) and USDA have developed a more efficient and proactive set of regulations, and have begun to progressively apply these to the food industry.

Fresh-cut processors and most FDA-regulated products are not required by law to have a HACCP program. However, as suggested by the International Fresh Cut Produce Association (IFPA), it is recommended and prudent for food processors to have one in place. Some industries such as meat and seafood are required by law to have HACCP programs. HACCP is commonly used in the fresh-cut produce industry, and many customers require their suppliers to have such a program in place. The terms HACCP and food safety program are often used interchangeably and synonymously, however, HACCP is not the same as a food safety program, the terms are not interchangeable, and should not be used synonymously. HACCP programs are merely a component of an overall food safety program. It sits on top of the hierarchy of food safety programs and a HACCP plan cannot be established without prerequisite programs, such as GAPs, GMPs and Sanitation Standard Operating Procedures (SSOPs), in place.

Many of the principles of HACCP have been in place in the FDA-regulated low-acid canned food industry for a number of years. The FDA established HACCP for the seafood industry in a final rule on Dec. 18, 1995, for the meat and poultry industries in July 1996, and for the juice industry in a final rule released Jan. 19, 2001. The FDA is now considering developing regulations that would establish HACCP as the food safety standard throughout other categories in the food processing industry for both domestic and imported food products. To help determine the degree to which such regulations would be feasible, the agency is conducting pilot HACCP programs with volunteer food companies. The programs have included dairy, frozen dough, breakfast cereals, salad dressing, bread, flour and other products. Retail HACCP pilot programs also have been conducted in some states.

"Hazard analysis" refers to the identification of any ingredient, material or procedure that may pose an unacceptable health risk. The hazard analysis is an evaluation of potential biological, chemical and physical hazards associated with a particular product and process. It is used to determine which hazards are reasonably likely to occur and, if they do occur, how they can best be controlled. A critical control point (CCP) is a point, step or procedure in a food process at which a control measure can be applied and where such a measure is essential to prevent, eliminate or reduce an identified food hazard to an acceptable level. Government regulations require that the hazard analysis and the critical control points be documented for mandated plans. HACCP assesses everything from raw ingredients to product packaging and distribution, define the points where potential hazards (biological, chemical, and physical) may occur, and establish a means of monitoring these points to control these hazards.

A HACCP plan is developed in two stages: First, the food processor must complete a number of preliminary steps and second, he or she must implement the seven principles of HACCP.

Planning for HACCP

A number of preliminary steps should be taken during the initial planning of the HACCP program. These steps include:

- **Assemble the HACCP Team:** Depth and breadth are the aims here. An effective HACCP Team will represent all the plant functions that are affected by or have impact on food safety. The team may include Quality Assurance, Operations, Engineering, Maintenance and Legal departments. The team should also include hourly representatives as well as Management. This provides for a variety of inputs by persons with a diverse knowledge of operations; aids helps those involved to understand the hazards associated with the food and operations and controls specified in the HACCP system; and stimulates cooperation in implementing the system.
- **Describe the product:** The finished product should be fully described in terms of physical and chemical characteristics, process steps, preservation systems, packaging, shelf life, storage, and distribution. Special attention should be given to identify those product attributes that have direct impact on product safety.
- **Identify the intended use of the product:** Accurately describe the product in terms of preparation and consumption. Is it ready-to-eat (RTE), fully prepared and ready-to-heat (RTH), or raw and ready-to cook (RTC)? Is it for foodservice or retail? Who will eat it?
- **Construct process flow diagrams:** Providing a clear and simple description of the process. Knowing how the product moves through the plant, from receipt of raw materials to the formulation area, through the lines to the shipping door, is critical to preventing cross-contamination incidents.
- **Verify the process flow:** The Team should physically walk through the process to verify the accuracy of the process documentation

HACCP Principles

Careful attention at this stage of development will have an impact on how well the company is able to implement the seven principles of HACCP.

Principle 1. *Conduct a hazard analysis.* Collect and evaluate information on relevant hazards. Decide which are significant and should be addressed in the HACCP plan. List all hazards that may be reasonably expected to occur in ingredients and at each step, from primary production until the point of consumption. The hazard could be biological, such as a microbe; chemical, such as a toxin; or physical, such as glass or metal fragments.

Principle 2. *Identify critical control points.* For each process step at which a significant hazard has been identified, determine whether it is a CCP or not. These are points in a food's production, from its raw state through processing and shipping to the consumer, at which the potential hazard can be prevented, reduced or eliminated. Examples are cooking, cooling, packaging, and metal detection.

Principle 3. *Establish critical limits for each CCP.* These CCP's may include measurements of temperature, time, moisture level, acidity (pH), water activity (a_w), and sensory parameters such as visual appearance and texture. For a cooked food, for example, this might include setting the minimum cooking temperature and time required to ensure the elimination of any harmful microbes. Care should be taken to account for process capability when determining set points versus critical limits.

Principle 4. *Establish procedures to monitor the critical control points.* The Codex Alimentarious definition of monitoring is "The act of conducting a planned sequence of observations or measurements of control parameters to assess whether a CCP is under control." Monitoring procedures should specify what, where, when, how and by whom the monitoring is carried out.

Principle 5. *Establish corrective actions in order to deal with deviations when they occur.* These are written procedures to be followed when a deviation occurs. For example, this may include reprocessing or disposing of food if the minimum cooking temperature is not achieved.

Principle 6. *Establish procedures to verify that the system is working properly and to validate the effectiveness of critical controls.* These verification procedures may include auditing methods, as well as random sampling, procedures, and tests. For example, time-and-temperature recording devices would need to be used to verify that a cooking unit is working properly. Published microbiological studies on time and temperature factors for controlling foodborne pathogens is one example of validation.

Principle 7. *Establish effective record keeping and documentation to document the HACCP system.* This would include records of hazards and their control methods, the monitoring of safety requirements and action taken to correct potential problems. Records must be dated and signed, reviewed for completeness and compliance and retained. ▮

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Part II

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Prerequisite Programs - the Solid Foundation for an Effective Food Safety Program

Any building is only as strong as its foundation. Effective food safety programs are built upon the solid base of prerequisite programs, and these should be documented and implemented before considering a formal HACCP plan. In a sense, they are the heart of a food safety program. Programs such as sanitation, good manufacturing practices, training, pest management and crisis management must be well developed, documented and monitored. They do not necessarily need to be a part of the HACCP plan, but they need to be complete, thorough, and effectively support the HACCP plan with clear policies and instructions. Most important, they must verify performance and provide documented corrective action.

The effective management of sanitation, housekeeping and hygiene is a critical element of food safety and quality, requiring the involvement and cooperation of all operating departments and support groups. It requires specific policies covering requirements and expectations and training to communicate those requirements. A key element is management support and follow-up to assure that the requirements are properly met and that all sanitary standards are fully enforced. A processor should have documented cleaning procedures not only for operational areas and equipment but also the warehouse, storage, maintenance, employee support areas (locker rooms, cafeterias and break areas and toilet facilities) and other plant areas including outside and roof areas. This is generally recognized as a "Master Sanitation Schedule". The processor must have documented Standard Sanitation Operation Procedures including such things as cleaning methods, frequency, monitoring procedures and corrective actions.

Employees must observe the strictest of personal hygiene practices as outlined in the Code of Federal Regulations, Section 21, Part 110, Current Good Manufacturing Practices for food plants. This regulation establishes the minimum requirements for basic food handling, but many food products, such as Ready-to-Eat products require more stringent practices. The goal of high quality and long shelf life products also dictate adherence to a stricter standard. Consequently, a specific, documented, detailed and closely monitored management program is expected to cover this vital area of wholesome food production.

It is important to have a documented training program (in appropriate languages) for all employees including new hires, temporary employees and contract employees. The program should provide basic food handling training, refresher training for experienced employees, and specific training for identified jobs such as sanitarians or HACCP CCP positions.

A documented pest management policy and program should also be developed, utilizing the services of a licensed pest control contractor. It should outline and describe all procedures required to ensure that all the activities conducted by the Pest Control Operator and trained employees are properly carried out and recorded. Buildings, grounds and interior premises should be clean and maintained to eliminate pest harborage and access.

Fresh-cut produce processors are strongly encouraged to implement a crisis management program in light of potential food safety issues. Among other things this will ensure that a crisis management team and effective procedures are in place, should there be a need to recall defective products and ensure the coordination of information and return of defective product to protect customers from health risk or fatality. A mock recall and traceback investigation will identify the potential sources implicated in a foodborne outbreak, and determine and document the link in the chain that has been implicated during an epidemiological investigation of foodborne illness. Fresh fruits and vegetables are extremely difficult to traceback because in most instances lot numbers and grower identifications are not used or recorded on receipt and shipping records. For this reason, it is imperative to identify a crisis management and traceback protocol that will be quick, efficient and as accurate as possible.

The Integration of Hurdle Technologies into a Food Safety Program

Good food is safe food, and by the judicious application of a HACCP program, the fresh-cut processor can implement a program, whereby, safe production conditions are achieved. It is critical to understand the technologies and best practices associated with value-added processing, literally from "farm to fork", as these individually and collectively impact both product safety and product quality…and ultimately impact market potential. Technologies have been recently introduced, and others are on the horizon, that will enable even greater alternatives in developing prepared products that meet consumer needs for safety, as well as quality, convenience, and overall value. These technologies are called "hurdles" and are preventive tools designed to provide incremental enhancements of safety, and extend the shelf life of the food product. Hurdles are effectively "tools in the toolbox" that can be utilized by processors of fresh-cut produce and others involved in the product's chain from farm to fork.

It is essential that hurdle technologies be utilized, because we cannot rely exclusively on maintaining refrigerated conditions to assure the safety of these perishable foods. In fact, refrigeration alone is not enough to prevent the growth of some infectious or toxigenic microorganisms. Some types of foodborne disease require so few bacterial cells to cause an infection that significant growth on contaminated produce is not required to pose a significant hazard to consumers. Therefore, refrigeration alone of harvested produce is *not* a sufficient control, although it is of great value and is a contributing hurdle. In addition, post process contamination even at low levels may create a situation where pathogenic microorganisms may grow to high levels and cause illness and potentially death. Therefore, other barriers to microbial growth *must* be incorporated into these foods to yield a safe and stable system.

Clearly, raw material control and good agricultural practices (GAPs) are critical

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to the successful development of value-added produce products. Variety, source, season, initial maturity, processing maturity, slicing and cutting equipment, chemical or other treatments and packaging environment, temperature management, shipping, and handling all affect the quality and shelf life potential of fresh-cut produce...and impact product safety. Preharvest contamination-prevention programs and postharvest sanitation are key tools to preventing outbreaks. Some farming practices that were considered safe in previous years are a liability today. On-farm prevention programs should include basic sanitation practices for all harvest containers, contact surfaces, and postharvest washing among other things.

In typical produce operations, washing fruit and vegetables with clean, potable water and a chemical disinfectant will result in a 1-3 log reduction (or 10 to 1000 fold reduction) but have not been shown to *eliminate* microbial contamination. The disinfectant most widely used in fresh-cut operations is chlorine. Some pathogens are very resistant to chlorine and other disinfectants, however, and even sensitive ones such as *Salmonella* and *E. coli* may be located in inaccessible sites on the plant surface.

Other disinfectants utilized in fresh-cut operations include hydrogen peroxide, peroxyacetic acid, bromine, iodine, trisodium phosphate, acetic and /or lactic acids, ozone, and chlorine dioxide. Chlorine dioxide has become the post-rinse sanitizer of choice for many commercial food and equipment washes. When properly used, chlorine dioxide is easy and economical to use. It has little flavor impact on foods, doesn't foam and does a reasonable job of destroying pathogens, spoilage bacteria and yeast and mold that are common in food plants.

Recently, a new product has been introduced to the market that, using a unique disposable generation device, generates pure chlorine dioxide gas in solution—without requiring the addition of an acid. Activation is accomplished by the addition of tap water, and the concentration can then be diluted as desired. Biosteam Technologies, Inc. has contracted with the firm that manufactures this product to tailor applications for food processing uses. To extend shelf life for and reduce pathogenic microbes on processed or cut fruits and vegetables, 3 ppm concentrations of the solution can be used, followed by an additional potable water rinse. The chlorine dioxide can also be utilized for sanitation of non-porous food contact surfaces (typically 5ppm) such as those in most food handling equipment applications; non-food contact surfaces (typically 20 ppm); and disinfection applications (typically 100 ppm).

Chlorine dioxide gas, an oxidizer with more than twice the oxidation capacity of bleach, ozone, or peroxide but with lower oxidation potential, has been used to reduce microbial counts in apple juicing operations as well. Many small juice-producing companies do not have the pasteurization heating systems necessary to meet USDA requirements for elimnating biological contaminants, and therefore produce unpasteurized juice. Scientists at Purdue University tested the impact of chlorine dioxide gas at a concentration of 4 mg per liter for 30 minutes, and demonstrated a reduction of the level of *Listeria* organisms by more than 1,000-fold for all three areas of apple tested. On the pulp, the average was more than a 100,000-fold reduction. These results supported previous test results when Purdue scientists used the gas to sanitize green peppers.

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Hurdles can also include direct application of other wash aids that incorporate acidulants, antimicrobial agents, antioxidants, heat (i.e. blanching) and processes that control water activity. Other options also exist such as steam treatment to disinfect surfaces of whole fruits, for example, which can result in a 5-log or greater reduction of microbes, including *E. coli* 0157:H7. In addition, non-thermal processing hurdles can now be applied such as ultra high pressure processing, irradiation, pulsed light and pulsed electric field processing. Lastly, hurdles can be applied during the packaging process, and include the application of modified atmosphere packaging, clean room packaging, active packaging systems, intelligent packaging systems, and a variety of alternative packaging materials. Synergistic results can be achieved when hurdles are used in combination and are a very important consideration. Many of these technologies have been shown to significantly reduce levels of food spoilage and pathogenic microorganisms such as *E. coli* O157:H7, *Salmonella, Listeria,* and *Campylobacter.*

In a produce operation, modified atmosphere packaging via reduced-oxygen may be effectively applied to help a fresh-cut processor achieve a much longer shelf life. However, because MAP results in a dramatic change in the *time* it takes for product to spoil, and the *type* of bacteria that will cause this spoilage, it can create significant additional risk as well. Because resultant oxygen levels can be extremely low in the MAP package for an elongated period of time, an atmosphere that is conducive to growth of anaerobic bacteria may exist, which increases the likelihood that a pathogenic organism like *C. botulinum* can grow to produce toxin and cause foodborne disease. However, incorporation of other barriers and microbiological challenge studies can minimize such risks.

In conclusion, no innovative "magic bullet" exists that will allow for product safety in value-added fresh-cut products. Instead, it is the combination of multiple hurdle techniques, applied with consistency and attention to detail, which will ensure microbiological safety, extend shelf life, and enable successful marketability. HACCP offers a number of advantages to the food industry. ■

Editor's Note: *Part 1 of this article appeared in the February issue of* Fresh Cut, *pages 16 and 17.* *Lou Cooperhouse is director of the Food Innovation Research and Extension Center at Cook College, Rutgers University, and can be reached at Cooperhouse@ aesop.rutgers.edu.*
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