

## PRODUCE

### COMPARISON OF TREATMENT OF FRESH-CUT LETTUCE AND DICED TOMATOES WITH SODIUM HYPOCHLORITE AND CALCIUM HYPOCHLORITE FOR EFFECTS ON MICROBIOLOGICAL AND SENSORY QUALITIES

(J. L. Simmons J.-H. Ryu, and L. R. Beuchat)

Outbreaks of salmonellosis, shigellosis, and *Escherichia coli* O157:H7 and viral infections have been associated with consumption of fresh produce. In some countries, minimally processed produce is routinely washed with chlorinated water to reduce or eliminate pathogenic and spoilage microorganisms. Sodium hypochlorite (NaOCl) traditionally has been used to prepare treatment solutions containing desired concentrations of free (available) chlorine. It is known that treatment of some types of fresh-cut produce with calcium can result in a firming of tissue texture, thereby reducing the amount of fluid released, with a consequent preservation of sensory quality and extension of shelf life. The role of calcium in prolonging shelf life is attributed in part to stabilization of cell membranes by reacting with negatively charged phospholipids and proteins to prevent solute leakage. Theoretically, treatment solutions containing a given concentration of free chlorine at a particular pH and temperature should be equally effective in killing microorganisms on produce, regardless of the type of hypochlorite salt, i.e., NaOCl or calcium hypochlorite [Ca(OCl)<sub>2</sub>], used to achieve that concentration. A potential added benefit of using Ca(OCl)<sub>2</sub> may be the retention of sensory quality resulting from the presence of calcium in the treatment solution that may not be achieved using NaOCl.

We undertook a study to determine if the type of hypochlorite salt [NaOCl and Ca(OCl)<sub>2</sub>] used to prepare chlorinated water for sanitizing fresh-cut iceberg, Romaine, and mesclun lettuce, and diced tomatoes affects lethality to microflora naturally occurring on the produce, as well as sensory quality during subsequent storage at 4°C for up to 13 days. The type of hypochlorite salt did not have a significant effect ( $P > 0.05$ ) on reductions in mesophilic aerobic microorganisms (total counts) or yeasts and molds, regardless of the concentration of free chlorine (50 - 200 µg/ml) in solutions used to treat produce. Appearance, color, aroma, texture, and overall quality of treated fresh-cut lettuce and diced tomatoes were likewise unaffected by the type of hypochlorite salt used to prepare chlorine treatment solutions. While NaOCl and Ca(OCl)<sub>2</sub>, at concentrations evaluated in this study, were indistinguishable in terms of effects on microbiological and sensory quality of produce, the choice of hypochlorite salt used to prepare chlorinated water should also consider factors such as cost of the salt, ease of control of desired concentration in the water, worker safety, and problems associated with disposal of treatment water after it has been used. The advantages of selecting one hypochlorite salt over the other must be decided and evaluated by informed personnel in each fresh-cut produce operation.

### DETECTION OF *CYCLOSPORA* IN VEGETABLES AND POTENTIAL CONTAMINATION SOURCES IN ENDEMIC AREAS

(Y.R. Ortega, A. Robertson, V.A. Cama, A. Mann, L. Cabrera, C. Taquiri, L. Xiao, and R.H. Gilman)

*Cyclospora cayetanensis* causes gastrointestinal illness and it is thought that people get infected via the food- or water-borne routes. In this study, we investigated the presence of *Cyclospora* in vegetables and hands of produce vendors in Pampas de San Juan in Lima Peru, a community where *Cyclospora* is endemic. We also surveyed other potential contamination factors, such as river irrigation water and soil from three agricultural fields. Vegetables and hand washes were collected from 20 vendors from 4 markets at 3 survey dates in 2004. All samples were analyzed by microscopy and PCR-RFLP for the presence of *Cyclospora*. It was identified in vegetables in the March and June surveys, but not in December. Hand washes were positive only in the March survey, one with *Cyclospora* and two with *Eimeria* spp. Irrigation water with *Cyclospora* was identified in March in 2 of 3 rivers, and 2 of 3 soil samples and, 1 of 3 rivers in August. Our findings show a seasonal trend in the detection of *Cyclospora*, which mimics the presence of cyclosporiasis in the community. Detecting *Cyclospora* in vegetables, hands of vendors, irrigation water, and agricultural soil demonstrate the food and water-borne potential of this parasite and give new information to understand the dynamics of produce contamination.

### INFECTIONS ASSOCIATED WITH CANTALOUPE CONSUMPTION: A PUBLIC HEALTH CONCERN

(A. Bowen, A. Fry, G. M. Richards and L. R. Beuchat)

Fresh produce has been implicated in outbreaks of foodborne illness in the U.S. with increased frequency in the past two decades. Several factors may be contributing to this trend. Produce is now available year round as a result of global marketing and trade, and international travel and restaurant dining may enhance the likelihood of exposure of consumers to contaminated produce. In addition, fresh fruits and vegetables have been promoted to consumers as an important part of a healthy lifestyle. Numerous campaigns have highlighted the nutritional value of produce, resulting in an increase in per capita consumption. Cantaloupe is among the fresh fruits that are being consumed in larger quantities in recent years, which may be a contributing factor to the increased frequency of cantaloupe-associated outbreaks. Recently, several large outbreaks of *Salmonella enterica* serotype Poona infections have been associated with consuming cantaloupes, highlighting the need for enhancing cantaloupe safety and resulting in importation restrictions for offending producers. We reviewed the CDC reports of foodborne outbreaks of infections from 50 states and four territories, as well as the global literature, with the goal of summarizing information on cantaloupe-associated outbreaks, etiologic agents of disease, potential sources of contamination, conditions affecting survival and growth of foodborne pathogens on whole and fresh-cut melons, and procedures for sanitization. Twenty-three outbreaks occurred between 1984 and 2002; 1434 people became ill, 42 were hospitalized, and 2 died in these outbreaks. Etiologic agents in the outbreaks included five serotypes of *Salmonella enterica*, *Campylobacter jejuni*, *Escherichia coli* O157:H7, and norovirus. We reviewed processes contributing to cantaloupe contamination, conditions affecting survival and growth of bacterial pathogens on melons, and potential methods for sanitization. For maximum safety, industry, federal, and international partners must collaborate to ensure that appropriate interventions are in place to minimize the risk of contamination and prevent the growth of pathogens during cantaloupe production, processing, storage, and preparation.

#### **CRYOTOLERANCE, ATTACHMENT, AND RECOVERABILITY OF *ESCHERICHIA COLI* O157:H7 AND SELECTED SURROGATES FROM ROMAINE LETTUCE LEAF SURFACES**

(M.A. Harrison)

A non-pathogenic bacterial species that responds to food processing treatments in a manner equivalent to a foodborne pathogen can potentially be used in actual food processing facilities to evaluate the effectiveness of the process to remove or eliminate the pathogen. Using the surrogate reduces the concerns related to the intentional introduction of pathogens in the food processing environment. It is important that the surrogate behave in a manner similar to that of the pathogenic microorganisms of interest. Surrogates have been evaluated and recommended for some heat, acidification, and drying procedures used in food processing. There is little work related to having suitable surrogates available to evaluate the fate of pathogens on refrigerated foods. With recent foodborne illness outbreaks related to fresh produce, it is important to have tools which would allow for the evaluation of possible microbial intervention processes on these refrigerated products. The objectives of the study were to determine if non-pathogenic *E. coli* strains could serve as surrogates of *E. coli* O157:H7 for attachment and recoverability studies involving chilled produce and to investigate the effect starvation and cold stress have on the behavior of *E. coli* O157:H7 and selected surrogates.

Five nonpathogenic *E. coli* strains were evaluated for behavior similar to that of *E. coli* O157:H7. The organisms were grown under conditions with minimal nutrients to create starved conditions. To evaluate response to cryotolerance, starved cells were frozen in sterile deionized water at  $-18^{\circ}\text{C}$  for 1, 2, 4 and 7 d. After storage at  $-18^{\circ}\text{C}$ , control and starved cells were thawed at room temperature and the viable population was determined. To determine whether the possible surrogates attach to lettuce surfaces and can be recovered or removed from the surfaces at a similar rate to *E. coli* O157:H7, romaine lettuce pieces were inoculated with each organism. After 1 hour, pieces were gently rinsed with either sterile deionized water or with chlorinated water.

All *E. coli* strains tested exhibited cryotolerance with less than 1 log CFU/ml decrease over 7 days of storage. In determining the attachment rate to lettuce, it was determined that *E. coli* ATCC 25922 exhibited the greatest attachment rate (79% compared to *E. coli* O157:H7). After chlorine treatment, *E. coli* ATCC 25922 population decreased by a similar rate to that of *E. coli* O157:H7. *E. coli* ATCC 25922 also had similar hydrophobicity compared to *E. coli* O157:H7. Cryotolerance and survival of starved organisms were measured after *E. coli* ATCC 25922 and *E. coli* O157:H7 were held in sterile deionized water for starvation ( $37^{\circ}\text{C}$  for 4 hours,  $20^{\circ}\text{C}$  for 24 hours, or  $4^{\circ}\text{C}$  for 7 days). Both stressed *E. coli* O157:H7 and stressed *E. coli* ATCC 25922 exhibited greater cryotolerance than nonstressed control cells. Populations of *E. coli* ATCC 25922 and *E. coli* O157:H7 were reduced by similar amounts (by approx. 99%) after washing with chlorinated water regardless of starvation conditions. *E. coli* ATCC

25922 was found to be a useful surrogate for *E. coli* O157:H7 for studies involving attachment and recoverability of chilled produce.

