ILSI North America

Food Safety Briefs

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E. coli

Effectiveness of Active Packaging on Control of Escherichia Coli O157:H7 and Total Aerobic Bacteria on Iceberg Lettuce

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Journal of Food Science, Vol. 80, No. 6; pp. M1325–M1329, 2015

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Link to full text: Click here

Significance: Some of the packaging structures evaluated in this study can be used to control the presence of foodborne pathogens on leafy green vegetables.

This study evaluated the efficacy of sustained active packaging on control of Escherichia coli O157:H7 and total aerobic bacteria on lettuce. Commercial Iceberg lettuce was inoculated with a 3-strain mixture of E. coli O157:H7 at 102 or 104 CFU/g. The contaminated lettuce and un-inoculated controls were placed respectively in 5 different active packaging structures. Traditional, nonactive packaging structure was included as controls. Results showed that packaging structures with ClO2 generator, CO2 generator, or one of the O2 scavengers effectively controlled the growth of E. coli O157:H7 and total aerobic bacteria under all storage conditions. Packaging structure with the ClO2 generator was most effective and no E. coli O157:H7 was detected in samples packaged in this structure except for those that were inoculated with 4 log CFU/g of E. coli O157:H7 and stored at 22 °C. Packaging structures with an oxygen scavenger and the allyl isothiocyanate generator were mostly ineffective in control of the growth of the bacteria on Iceberg lettuce.

Inactivation of Escherichia coli O157:H7 on Orange Fruit Surfaces and in Juice Using Photocatalysis and High Hydrostatic Pressure

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Link to full text: Click here

Significance: High hydrostatic pressure treatment did not affect the pH, °Brix, or color of juice; however, the ascorbic acid concentration and pectinmethylesterase activity were reduced.

Nonpasteurized orange juice is manufactured by squeezing juice from fruit without peel removal. Fruit surfaces may carry pathogenic microorganisms that can contaminate squeezed juice. Titanium dioxide–UVC photocatalysis (TUVP), a nonthermal technique capable of microbial inactivation via generation of hydroxyl radicals, was used to decontaminate orange surfaces. Levels of spot-inoculated Escherichia coli O157:H7 (initial level of 7.0 log CFU/cm^2)

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on oranges (12 cm^2) were reduced by 4.3 log CFU/ml when treated with TUVP (17.2 mW/cm^2). Reductions of 1.5, 3.9, and 3.6 log CFU/ml were achieved using tap water, chlorine (200 ppm), and UVC alone (23.7 mW/cm^2), respectively. E. coli O157:H7 in juice from TUVP (17.2 mW/cm^2)–treated oranges was reduced by 1.7 log CFU/ml. After orange juice was treated with high hydrostatic pressure (HHP) at 400 MPa for 1 min without any prior fruit surface disinfection, the level of E. coli O157:H7 was reduced by 2.4 log CFU/ml. However, the E. coli O157:H7 level in juice was reduced by 4.7 log CFU/ml (to lower than the detection limit) when TUVP treatment of oranges was followed by HHP treatment of juice, indicating a synergistic inactivation effect. The inactivation kinetics of E. coli O157:H7 on orange surfaces followed a biphasic model.

Investigation into Formation of Lipid Hydroperoxides from Membrane Lipids in Escherichia coli O157:H7 following Exposure to Hot Water

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Journal of Food Protection, Vol. 78, No. 6; pp. 1197–1202(6), 2015

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Significance: Hot water application prior to organic acid application may function to increase the sensitivity of E. coli O157:H7 cells by degrading membrane lipids.

It was hypothesized that Escherichia coli O157:H7 exposure to hot water in vitro at rising temperatures for longer time periods would result in increasing deterioration of bacterial outer membrane lipids, sensitizing the pathogen to subsequent lactic acid application. Cocktails of E. coli O157:H7 strains were subjected to hot water at 25 (control) 65, 75, or 85°C incrementally up to 60 s, after which surviving cells were enumerated by plating. Formation of lipid hydroperoxides from bacterial membranes and cytoplasmic accumulation of L-lactic acid was quantified spectrophotometrically. Inactivation of E. coli O157:H7 proceeded in a hot water exposure duration- and temperature-dependent manner, with populations being reduced to nondetectable numbers following heating of cells in 85°C water for 30 and 60 s ($P < 0.05$). Lipid hydroperoxide formation was not observed to be dependent upon increasing water temperature or exposure period.

Diversity of Shiga Toxin-Producing Escherichia coli (STEC) O26:H11 Strains Examined via *stx* Subtypes and Insertion Sites of Stx and EspK Bacteriophages

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Applied and Environmental Microbiology, Vol. 81, No. 11; pp. 3712–3721, 2015

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Link to full text: Click here

Significance: The differences in the stx subtypes and Stx phage insertion sites observed in STEC O26:H11 according to their origin might reflect that strains circulating in cattle and foods are clonally distinct from those isolated from human patients.

Seventy-four Shiga toxin-producing Escherichia coli (STEC) O26:H11 strains of various origins (including human, dairy, and cattle) were characterized for their Shiga toxin (stx) subtypes and Stx phage chromosomal insertion sites. The majority of food and cattle strains possessed the stx1a subtype, while human

strains carried mainly stx1a or stx2a. The wrbA and yehV genes were the main Stx phage insertion sites in STEC O26:H11, followed distantly by yecE and sbcB. Interestingly, the occurrence of Stx phages inserted in the yecE gene was low in dairy strains. In most of the 29 stx-negative E. coli O26:H11 strains also studied here, these bacterial insertion sites were vacant. Multilocus sequence typing of 20 stx-positive or stx-negative E. coli O26:H11 strains showed that they were distributed into two phylogenetic groups defined by sequence type 21 (ST21) and ST29. Finally, an EspK-carrying phage was found inserted in the ssrA gene in the majority of the STEC O26:H11 strains but in only a minority of the stx-negative E. coli O26:H11 strains.

Foodborne Pathogens

Combined Effect of Thermosonication and Slightly Acidic Electrolyzed Water to Reduce Foodborne Pathogens and Spoilage Microorganisms on Fresh-cut Kale

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Link to full text: Click here

Significance: The combined treatment of thermosonication and slightly acidic electrolyzed water has the potential as a decontamination process in fresh-cut industry.

This study evaluated the efficacy of individual treatments (thermosonication [TS+DW] and slightly acidic electrolyzed water [SAcEW]) and their combination on reducing Escherichia coli O157:H7, Listeria monocytogenes, and spoilage microorganisms (total bacterial counts [TBC], Enterobacteriaceae, Pseudomonas spp., and yeast and mold counts [YMC]) on fresh-cut kale. For comparison, the antimicrobial efficacies of sodium chlorite (SC; 100 mg/L) and sodium hypochlorite (SH; 100 mg/L) were also evaluated. The efficacy of TS+DW or SAcEW was enhanced at 40 °C for 3 min, with an acoustic energy density of 400 W/L for TS+DW and available chlorine concentration of 5 mg/L for SAcEW. At 40 °C for 3 min, combined treatment of thermosonication 400 W/L and SAcEW 5 mg/L (TS+SAcEW) was more effective in reducing microorganisms compared to the individual treatments (SAcEW, SC, SH, and TS+DW) and combined treatments (TS+SC and TS+SH), which significantly ($P < 0.05$) reduced E. coli O157:H7, L. monocytogenes, TBC, Enterobacteriaceae, Pseudomonas spp., and YMC by 3.32, 3.11, 3.97, 3.66, 3.62, and >3.24 log CFU/g, respectively.

Growth of Salmonella enterica and Listeria monocytogenes on Fresh-Cut Cantaloupe under Different Temperature Abuse Scenarios

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Journal of Food Protection, Vol. 78, No. 6; pp. 1125–1131(7), 2015

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Link to full text: Click here

Significance: Significant deterioration of produce visual quality and tissue integrity was observed under various temperature abuse conditions.

The impact of commonly encountered temperature abuse scenarios on the proliferation of Salmonella enterica and Listeria monocytogenes on fresh-cut cantaloupe was examined. Inoculated fresh-cut cantaloupe cubes were subjected

to various temperature abuse conditions, and the growth of S. enterica and L. monocytogenes was determined. During 1 week of storage, Salmonella cell counts on fresh-cut cantaloupe increased by –0.26, 1.39, and 2.23 log units at 4°C (control), 8°C, and 12°C (chronic temperature abuse), respectively, whereas that of L. monocytogenes increased by 0.75, 2.86, and 4.17 log units. Under intermittent temperature abuse conditions, where storage temperature fluctuated twice daily to room temperature for 30 min, Salmonella cell count increased by 2.18 log units, whereas that of L. monocytogenes increased by 1.86 log units. In contrast, terminal acute temperature abuses for 2 to 4 h resulted in upwards to 0.6 log unit for Salmonella, whereas the effect on L. monocytogenes was less significant compared with L. monocytogenes on cut cantaloupe stored at 4°C.

Comparative Effects of Ohmic and Conventional Heating for Inactivation of Escherichia coli O157:H7, Salmonella enterica Serovar Typhimurium, and Listeria monocytogenes in Skim Milk and Cream

S-S. Kim, D-H. Kang

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Link to full text: Click here

Significance: Although there was little evidence of a nonthermal effect of ohmic heating, the results demonstrate significant advantages in the use of ohmic heating over conventional methods for pasteurizing skim milk and cream.

The effect of ohmic and conventional heating for pasteurizing skim milk and cream was examined. All treatment conditions for ohmic and conventional heating were identical except for composition of the heating chamber. In most cases, the reduction of three pathogens did not differ significantly between ohmic heating and conventional heating at fixed treatment temperatures and times. However, temperature can be increased more rapidly with ohmic than with conventional heating treatment, both in skim milk and in cream. Therefore, E. coli O157:H7, Salmonella Typhimurium, and L. monocytogenes were inactivated more effectively by ohmic heating treatment for the same treatment time intervals. Also, the time required for pathogen populations to decrease to below the detection limit was less for ohmic heating than conventional heating. Quality aspects (viscosity, pH, and color) of skim milk and cream suffered less degradation by ohmic than by conventional heating.

Irrigation is Significantly Associated with an Increased Prevalence of Listeria monocytogenes in Produce Production Environments in New York State

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Link to full text: Click here

Significance: Intervention at the irrigation level may reduce the risk of produce contamination.

This study was conducted to determine the prevalence of Listeria monocytogenes, Listeria species (including L. monocytogenes), Salmonella, and Shiga toxin–producing Escherichia coli (STEC) in produce production environments and to identify environmental factors and management practices associated with their

isolation. Ten produce farms in New York State were sampled during a 6-week period in 2010, and 124 georeferenced samples (80 terrestrial, 33 water, and 11 fecal) were collected. L. monocytogenes, Listeria spp., Salmonella, and STEC were detected in 16, 44, 4, and 5% of terrestrial samples, 30, 58, 12, and 3% of water samples, and 45, 45, 27, and 9% of fecal samples, respectively. Environmental factors and management practices were evaluated for their association with terrestrial samples positive for L. monocytogenes or other Listeria species by univariate logistic regression. Although univariate analysis identified associations between isolation of L. monocytogenes or Listeria spp. from terrestrial samples and various water-related factors (e.g., proximity to wetlands and precipitation), multivariate analysis revealed that only irrigation within 3 days of sample collection was significantly associated with isolation of L. monocytogenes (odds ratio = 39) and Listeria spp. (odds ratio = 5) from terrestrial samples.

Listeria

Controlling Listeria monocytogenes in Cold Smoked Salmon with the Antimicrobial Peptide Salmine

C. Cheng, F. Arritt, C. Stevenson

Journal of Food Science, Vol. 80, No. 6; pp. M1314–M1318, 2015

DOI: 10.1111/1750-3841.12886

Link to full text: Click here

Significance: There is potential for salmine to be used as a natural hurdle to inhibit growth of Listeria monocytogenes due to post process contamination.

The purpose of this study was to determine the anti-listeria activity of salmine in smoked salmon by measuring the viable counts of Listeria monocytogenes (LM) over time. (Salmine is a cationic antimicrobial peptide derived from the milt of salmon that has been shown to inhibit the growth of LM in vitro.) Cold smoked salmon was treated with a salmine solution or coated with agar or k-carrageenan films incorporating salmine to maintain a high surface concentration of the antimicrobial. Samples were then inoculated with approximately 1.0 × 103 cells of LM. The viable counts were then enumerated throughout 4 wk at 4 °C storage. It was found that 5 mg/g salmine delayed the growth of LM on smoked salmon. These samples had significantly lower LM counts than on the untreated samples on days 13 and 22. Edible films did not significantly improve the antimicrobial efficacy of salmine. The peptide combined with biopolymers also had lower antimicrobial activity in vitro when compared to salmine alone.

Comparative Study on the Efficacy of Bacteriophages, Sanitizers, and UV Light Treatments to Control Listeria monocytogenes on Sliced Mushrooms (Agaricus bisporus)

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Link to full text: Click here

Significance: Of the treatments evaluated, UV–hydrogen peroxide holds promise to control Listeria monocytogenes on mushroom surfaces.

The following reports on a comparative study on the efficacy of different decontamination technologies to decrease Listeria monocytogenes inoculated onto

white sliced mushrooms and assesses the fate of residual levels during posttreatment storage under aerobic conditions at 8°C. The treatments were chemical (hydrogen peroxide, peroxyacetic acid, ozonated water, electrolyzed water, chitosan, lactic acid), biological (Listeria bacteriophages), and physical (UV-C, UV–hydrogen peroxide). None of the treatments achieved >1.2 log CFU reduction in L. monocytogenes levels; bacteriophages at a multiplicity of infection of 100 and 3% (vol/vol) hydrogen peroxide were the most effective of the treatments tested. However, growth of residual L. monocytogenes during posttreatment storage attained levels equal to or greater than levels in the nontreated controls. The growth of L. monocytogenes was inhibited on mushrooms treated with chitosan, electrolyzed water, peroxyacetic acid, or UV. Yet, L. monocytogenes inoculated onto mushrooms and treated with UV–hydrogen peroxide decreased during posttreatment storage, through a combination of sublethal injury and dehydration of the mushroom surface. Although mushrooms treated with UV–hydrogen peroxide became darker during storage, the samples were visually acceptable relative to controls.

Effect of Acidified Sorbate Solutions on the Lag-Phase Durations and Growth Rates of Listeria monocytogenes on Meat Surfaces

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Significance: Sorbate concentration and pH level were significant factors affecting the lag-phase and growth rates of L. monocytogenes and that the combination of sorbate and low pH has potential for use as a surface treatment to control L. monocytogenes on meat surfaces.

This study quantified the lag-phase durations (LPD) and growth rates (GR) of Listeria monocytogenes on the surfaces of cooked ham as affected by sorbate solutions of different concentrations and pH levels. Slices of cooked ham inoculated with a four-strain mixture of L. monocytogenes (ca. 103 CFU/g) were surface treated with sorbate solutions of 0-4% (wt/vol) at pH 4.0-6.5, vacuum packaged, and stored at 4-12°C for ≤45 days. The LPD and GR of L. monocytogenes were used to develop response surface models, which estimated that the LPD of L. monocytogenes in samples treated with solutions of pH 4.0-5.5 (no sorbate) were 0 to 11 days and the GR were 0.25-0.36 log CFU/day, respectively, at 4°C. With the treatments of 2 and 4% (wt/vol) sorbate solutions, the LPD were estimated to be extended to 2 to 26 days and 34 to >45 days, and the GR were reduced to 0.15 to 0.30 and 0 to 0.19 log CFU/day, respectively. At 4°C, increasing sorbate concentrations by 1% (wt/vol) to 2, 3, and 4% (wt/vol) at pH 5.5-4.0 led to an extension of LPD by 2 to 11, 10 to 19, and 18 to 27 days, whereas the GR were reduced by 0.037 to 0.055, 0.048 to 0.066, and 0.060 to 0.078 log CFU/day, respectively. Sorbate also extended the LPD and reduced the GR of L. monocytogenes at 8 and 12°C.

Stability of Sublethal Acid Stress Adaptation and Induced Cross Protection Against Lauric Arginate in Listeria Monocytogenes

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International Journal of Food Microbiology, Vol. 203, 16 June 2015; pp. 49–54, 2015

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Link to full text: Click here

Significance: The stability of acid adaptation in L. monocytogenes under cold conditions should be taken into account when the risk analysis is performed during food processing.

The stability of acid stress adaptation in Listeria monocytogenes and its induced cross protection effect against GRAS (generally recognized as safe) antimicrobial compounds was investigated. The acid stress adaptation in L. monocytogenes was initially induced in pH 5.0 tryptic soy broth supplemented with 0.6% yeast extract (TSB-YE) at 37 °C. Subsequently, the stability of acid stress adaptation was determined at 37°C, 22°C or 4°C in broth and in different food substrates. Then, the acid stress adaptation induced cross protection against lauric arginate (LAE) and its stability was investigated in TSB-YE, milk and carrot juice. The acid stress adaptation was stable at 4°C up to 24 h but was reversed at 37°C or 22°C within 2 h. In the cross protection assay with LAE, the acid stress adapted cells had approximately 2 log CFU/ml greater survival than non-adapted cells in broth at 22°C or in milk and carrot juice at 4°C. The acid adaptation induced cross protection against LAE in L. monocytogenes was reversible within 1 h at 4°C in the absence of sublethal acid stress.

Food Allergy

A Retrospective Analysis of Allergic Reaction Severities and Minimal Eliciting Doses for Peanut, Milk, Egg, and Soy Oral Food Challenges

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Food and Chemical Toxicology, Vol. 80, June 2015; pp. 92–100, 2015

DOI: 10.1016/j.fct.2015.02.023

Link to full text: Click here

Significance: The relationship between threshold dose distribution and reaction severity differed between peanut and other allergens, and severe reactions were found to occur in some patients at low minimal eliciting doses for all of these food allergens.

The minimum amount of protein needed to provoke an allergic reaction in an individual patient (the minimal eliciting dose (MED)) ranges from a few micrograms to several grams. To determine whether a retrospective analysis of published data from oral food challenges could be used to assess the potential relationship between MEDs and reaction severities at the MEDs, a three class (mild, moderate, severe) reaction grading system was developed by integrating previously published reaction grading systems. MEDs and symptoms were collected from food challenge studies and each reaction was graded using the integrated grading system. Peanut allergic patients who experienced severe reactions had significantly higher MEDs and threshold distribution doses than those who experienced mild and moderate reactions. No significant differences in threshold distributions according to the severity grading were found for milk, egg and soy.

Caffeine

Assessing Dietary Exposure to Caffeine From Beverages in the U.S. Population Using Brand-Specific Versus Category-Specific Caffeine Values

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Food and Chemical Toxicology, Vol. 80, June 2015; pp. 247–252, 2015

DOI: 10.1016/j.fct.2015.03.024

Link to full text: Click here

Significance: As the caffeinated beverage marketplace continues to evolve, the use of more detailed, brand-specific data will likely strengthen the assessment of caffeine exposure in the United States.

This study compared two methods of assigning caffeine values to beverages: brand-specific values versus an aggregate single value representing a broader range of products within a beverage category (i.e., category-specific). The two methods yielded some small, but statistically significant differences in the estimation of caffeine intake from coffee, tea, and carbonated soft drinks (CSDs) for all ages combined and within several of the adult age groups (i.e., 35–49, 50–64, and ≥65 years). These differences, while small, suggest that detailed brand-specific data, particularly for CSDs, commercially pre-packaged or bottled teas, coffee, and specialty coffee drinks, provide more accurate estimates of caffeine exposure for some age groups. Despite these differences, these data provide some assurance that studies using a single aggregate caffeine value provide reasonable measures of caffeine exposure, particularly for studies conducted over a decade ago when there were fewer caffeinated products and brand-specific data available.

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