ILSI North America

Food Safety Briefs

April 2015

E. Coli

Multifactorial Effects of Ambient Temperature, Precipitation, Farm Management, and Environmental Factors Determine the Level of Generic Escherichia coli Contamination on Preharvested Spinach

S. Park, S. Navratil, A. Gregory, A. Bauer, I. Srinath, B. Szonyi, et al.

Applied and Environmental Microbiology, Vol. 81, No. 7; pp. 2635–2650, 2015

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Link to full text: Click here

Significance: Farm management, the environment and weather factors determined the odds of a contamination event in spinach.

A repeated cross-sectional study was conducted to identify farm management, environment, weather, and landscape factors that predict the count of generic Escherichia coli on spinach at the preharvest level. E. coli was enumerated for 955 spinach samples collected on 12 farms in Texas and Colorado between 2010 and 2012. Farm management and environmental characteristics were surveyed using a questionnaire. Weather and landscape data were obtained from National Resources Information databases. A two-part mixed-effect negative binomial hurdle model was used to identify factors affecting E. coli counts on spinach. Results indicated that the odds of a contamination event (non-zero versus zero counts) vary by state (odds ratio [OR] = 108.1). Odds of contamination decreased with implementation of hygiene practices (OR = 0.06) and increased with an increasing average precipitation amount (mm) in the past 29 days (OR = 3.5) and the application of manure (OR = 52.2). On contaminated spinach, E. coli counts increased with the average precipitation amount over the past 29 days. The relationship between E. coli count and the average maximum daily temperature over the 9 days prior to sampling followed a quadratic function with the highest bacterial count at around 24°C.

Salmonella

Survival of Salmonella on Chamomile, Peppermint, and Green Tea during Storage and Subsequent Survival or Growth following Tea Brewing

S.E. Keller, C.N. Stam, D.R. Gradl, Z. Chen, E.L. Larkin, S.R. Pickens, et al.

Journal of Food Protection, Vol. 78, No. 4; pp. 661–667, 2015

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Significance: If Salmonella survives after storage, it may also survive and grow after a home brewing process.

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The survival of Salmonella on dried chamomile flowers, peppermint leaves, and green tea leaves stored under different conditions was examined. Survival and growth of Salmonella was also assessed after subsequent brewing using dried inoculated teas. A Salmonella enterica serovar cocktail was inoculated onto different dried tea leaves or flowers to give starting populations of approximately 10 log CFU/g. The inoculum was allowed to dry prior to storage under 25 and 35°C at low (<30% relative humidity [RH]) and high (>90% RH) humidity levels. Under the four storage conditions tested, survival followed the order: 25°C with low RH > 35°C with low RH > 25°C with high RH > 35°C with high RH. Salmonella losses at 25°C with low RH occurred primarily during drying. In contrast, Salmonella decreased below detection after 45 days at 35°C and high RH in all teas tested. The thermal resistance of Salmonella was assessed at 55°C immediately after inoculation of tea leaves or flowers, after drying (24 h) onto tea leaves or flowers, and after 28 days of storage at 25°C with low RH. All conditions resulted in similar D-values (2.78 ± 0.12, 3.04 ± 0.07, and 2.78 ± 0.56, at 0 h, 24 h, and 28 days, respectively), indicating thermal resistance of Salmonella in brewed tea did not change after desiccation and 28 days of storage. In addition, all brewed teas tested supported the growth of Salmonella.

Foodborne Pathogens

Survival of Salmonella and Escherichia coli O157:H7 on Strawberries, Basil, and Other Leafy Greens during Storage

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Link to full text: Click here

Significance: Avoiding contamination at cultivation is important as Salmonella and E. coli O157:H7 survive during storage, and strawberries, basil, and other leafy green leaves are consumed without inactivation treatment.

The survival of Salmonella and Escherichia coli O157:H7 on strawberries, basil leaves, and other leafy greens was assessed at cold (<7°C) and ambient temperatures. All commodities were spot inoculated with E. coli O157:H7 or Salmonella to obtain an initial inoculum of 5-6 log and 4-5 log CFU/g for strawberries and leafy greens, respectively. Both Salmonella and E. coli O157:H7 showed a gradual decrease in numbers if inoculated on strawberries, with a similar reduction observed at 4, 10, and 15°C (2-3 log after 5 days). However, at 15°C (and 10°C for E. coli O157:H7), the survival experiment stopped before day 7, as die-off of both pathogens below the lower limit of detection was achieved or spoilage occurred. At 22°C, strawberries were moldy after 2 or 4 days. At that time, a 1- to 2-log reduction of both pathogens had occurred. A restricted die-off (on average 1.0 log) and increase (on average, 0.5 log) of both pathogens on basil leaves occurred after 7 days of storage at 7 and 22°C, respectively. On leafy greens, a comparable decrease as on basil was observed after 3 days at 7°C. At 22°C, both pathogens increased to higher numbers on fresh-cut iceberg and butterhead lettuce leaves (on average 1.0 log).

Evaluation of Novel Micronized Encapsulated Essential Oil–Containing Phosphate and Lactate Blends for Growth Inhibition of Listeria monocytogenes and Salmonella on Poultry Bologna, Pork Ham, and Roast Beef Ready-to-Eat Deli Loaves

G. Casco, T.M. Taylor, C. Alvarado

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doi: 10.4315/0362-028X.JFP-14-273
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Significance: The encapsulated essential oil with phosphate version 2 at 0.60% can function to replace potassium lactate to limit growth of Salmonella and Listeria monocytogens in ready-to-eat deli products.

Two proprietary noncommercial essential oil–containing phosphate blends were evaluated for antimicrobial activity against Salmonella enterica cocktail (SC)– and Listeria monocytogenes (Lm)–inoculated deli meat products made from pork, poultry, or beef. Four treatments were tested: nonencapsulated essential oil with phosphate version 1 at 0.45% of final batch (EOV145; chicken and pork, or EEOV245 beef), micronized encapsulated essential oil with phosphate version 2 at 0.60% of final batch (EEOV260), a 2.0% potassium lactate (PL) control, and a negative control (CN) with no applied antimicrobial agent. Compared with the CN, none of the antimicrobial agents (EEOV260, EOV145, PL) successfully limited Lm or SC growth to <2.0 log cycles over 49 days or 35 days of refrigerated storage, respectively. The PL and EEOV260-treated ham loaves did show Lm growth limiting ability of up to 1 log cycle by days 35 and 42. On formed roast beef, the EEOV260 was able to extend the lag phase and inhibited the growth of Lm in the same manner as the PL. For SC-treated samples, a lag-phase extension was observed through 35 days of storage in poultry bologna treated with EEOV260 compared with the other samples. For pork deli loaves, the EEOV260 inhibited growth of SC at days 21 and 28 to the same level of efficacy as PL (0.5 log cycle). In roast beef samples, on day 35, the SC growth was inhibited ca. 0.5 log CFU/g by EEOV260 when compared with the CN.

The Growing Season, but Not the Farming System, Is a Food Safety Risk Determinant for Leafy Greens in the Mid-Atlantic Region of the United States

S.C. Marine, S. Pagadala, F. Wang, D.M. Pahl, M.V. Melendez, W.L. Kline, et al.
Applied and Environmental Microbiology, Vol. 81, No. 7; pp. 2395–2407, 2015
doi: 10.1128/AEM.00051-15
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Significance: Seasonal events, weather conditions, and proximity of compost piles might be important factors contributing to microbial contamination on farms growing leafy greens.

To assess farm-level risk factors, bacterial indicators, Salmonella enterica and Shiga toxin-producing Escherichia coli (STEC) from 32 organic and conventional farms were analyzed. A total of 577 leafy greens, irrigation water, compost, field soil, and pond sediment samples were collected. Salmonella was recovered from 2.2% of leafy greens (n=369) and 7.7% of sediment (n=13) samples. There was an association between Salmonella recovery and growing season (fall versus spring) (P=0.006) but not farming system (organic or conventional) (P=0.920) or region (P=0.991). No STEC was isolated. In all, 10% of samples were positive for E. coli: 6% of leafy greens, 18% of irrigation water, 10% of soil, 38% of sediment, and 27% of compost samples. Farming system was a significant factor for total coliforms (TC) (P<0.001), with higher counts from organic farm samples. Growing season was a factor for aerobic mesophiles on leafy greens (P=0.004), with higher levels in fall than in spring. Water source was a factor for all indicator bacteria (P<0.001).

Survival and Growth of Salmonella Typhimurium, Escherichia coli O157:H7 and Staphylococcus aureus in Eggplant Dip During Storage

T.M. Osaili, A.A. Al-Nabulsi, Z. Jaradat, R.R. Shaker, D.Z. Alomari, M.M. Al-Dabbas, et al.

International Journal of Food Microbiology, Vol. 198, 2 April 2015; pp. 37–42, 2015

doi: 10.1016/j.ijfoodmicro.2014.12.025

Link to full text: Click here

Significance: The use of citric acid at 0.4–0.8% can inhibit the growth of S. aureus in eggplant dip, but adequate refrigeration is essential to minimize risk from this and other pathogens in this product.

This study examined the effects of citric acid on the survival of pathogenic microorganisms (Salmonella Typhimurium, Escherichia coli O157:H7 and Staphylococcus aureus) and naturally present organisms (lactic acid bacteria [LAB], aerobic bacteria [APC], and yeast and mold [YM]) in eggplant dip during storage. Eggplant dip with 0, 0.2, 0.4, 0.6 or 0.8% citric acid was inoculated with S. Typhimurium, E. coli O157:H7 or S. aureus and stored at 4, 10 and 21 °C for ≤ 15 d. The survival of the inoculated microorganisms was monitored, and LAB, APC, YM numbers and pH were determined. There was no significant effect of citric acid on inoculated S. Typhimurium and E. coli O157:H7. Salmonella and E. coli O157:H7 survived > 7 d with little reduction in viability. Reduction of S. aureus viability increased with citric acid concentration and reached > 3.0 log10 CFU/g by 15 d at 4 °C. At 21 °C, 0.6 and 0.8% citric acid significantly reduced LAB. Citric acid had significant effects on samples stored at 10 and 21 °C.

Norovirus

Efficacy and Mechanisms of Murine Norovirus Efficacy and Mechanisms of Murine Norovirus Inhibition by Pulsed-Light Technology

A. Vimont, I. Fliss, J. Jean

Applied and Environmental Microbiology, Vol. 81, No. 8; pp. 2950–2957, 2015

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Link to full text: Click here

Significance: Pulsed-light technology could provide an effective alternative means of inactivating noroviruses in wastewaters, in clear beverages, in drinking water, or on food-handling surfaces in the presence or absence of biofilms.

Pulse light was investigated for its efficacy in inactivating murine norovirus 1 (MNV-1) as a human norovirus surrogate in phosphate-buffered saline, hard water, mineral water, turbid water, and sewage treatment effluent and on food contact surfaces, including high-density polyethylene, polyvinyl chloride, and stainless steel, free or in an alginate matrix. The pulsed-light device emitted a broadband spectrum (200 to 1,000 nm) at a fluence of 0.67 J cm−2 per pulse, with 2% UV at 8 cm beneath the lamp. Reductions in viral infectivity exceeded 3 log10 in < 3 s (5 pulses; 3.45 J cm−2) in clear suspensions and on clean surfaces, and in 6 s (11 pulses; 7.60 J cm−2) on fouled surfaces except for stainless steel (2.6 log10). The presence of protein or bentonite interfered with viral inactivation. Pulsed light appeared to disrupt MNV-1 structure and degrade viral protein and RNA.

Electron Beam Inactivation of Tulane Virus on Fresh Produce, and Mechanism of Inactivation of Human Norovirus Surrogates by Electron Beam Irradiation

A. Predmore, G.C. Sanglay, E. DiCaprio, J. Li, R.M. Uribe, K. Le

International Journal of Food Microbiology, Vol. 198, 2 April 2015; pp. 28–36, 2015

doi: 10.1016/j.ijfoodmicro.2014.12.024

Link to full text: Click here

Significance: The mechanism of inactivation of electron beam was likely the same as gamma irradiation as the damage to viral constituents led to inactivation.

This study had three distinct goals: 1) to evaluate the sensitivity of a human norovirus surrogate, Tulane virus (TV), to electron beam (e-beam) irradiation in foods, 2) to compare the difference in sensitivity of TV and murine norovirus (MNV-1) to e-beam irradiation, and 3) to determine the mechanism of inactivation of these two viruses by e-beam irradiation. TV was reduced from 7 log10 units to undetectable levels at target doses of ≥16 kGy in strawberries and lettuce. MNV-1 was more resistant to e-beam treatment than TV. At target doses of 4 kGy, e-beam provided a 1.6 and 1.2 log reduction of MNV-1 in phosphate buffered saline (PBS) and Dulbecco's Modified Eagle Medium (DMEM), compared to a 1.5 and 1.8 log reduction of TV in PBS and Opti-MEM, respectively. Transmission electron microscopy revealed that increased e-beam doses negatively affected the structure of both viruses. Analysis of viral proteins by SDS-PAGE found that irradiation also degraded viral proteins. Using RT-PCR, irradiation was shown to degrade viral genomic RNA.

Norovirus Cross-Contamination during Preparation of Fresh Produce

S.F. Grove, A. Suriyanarayanan, B. Puli, H. Zhao, M. Li, D. Li, et al.

International Journal of Food Microbiology, Vol. 198, 2 April 2015; pp. 43–49, 2015

doi: 10.1016/j.ijfoodmicro.2014.12.023

Link to full text: Click here

Significance: Virions are transferred from one hand to the other during washing with and without soap.

This study examined cross-contamination of a human norovirus (HuNoV) surrogate, murine norovirus (MNV-1), during common procedures used in preparing fresh produce in a food service setting, including turning water spigots, handling and chopping Romaine lettuce, and washing hands. MNV-1 transfer coefficients varied by surface type, and a greater affinity for human hands and chopped lettuce was observed. During the chopping of Romaine lettuce, MNV-1 was transferred from either a contaminated cutting board (25% or 1.4-log transfer %) or knife (~ 100% or 2.0-log transfer %) to lettuce at a significantly greater rate than from contaminated lettuce to the board (2.1% or 0.3-log transfer %) and knife (1.2% or 0.06-log transfer %). For handwashing trials, only one hand was inoculated with MNV-1 prior to washing. The handwashing methods included rubbing hands under tap water for at least 5 s (average 2.8-log reduction) or washing hands for at least 20 s with liquid soap (average 2.9-log reduction) or foaming soap (average 3.0-log reduction). Despite the reductions of MNV-1 observed, residual virions were detected on both hands after washing in every replicate trial. MNV-1 transfers readily between common surfaces during food preparation.

Listeria

Antimicrobial Effects of Essential Oils, Nisin, and Irradiation Treatments against Listeria monocytogenes on Ready-to-Eat Carrots

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Link to full text: Click here

Significance: Combined treatments using nisin + carvacrol or nisin + mountain savory and irradiation at 1.0 kGy could be used as an effective method for controlling Listeria monocytogenes in minicarrots.

The study aimed at using essential oil (EO) alone or combined EO with nisin and low dose γ-irradiation to evaluate their antibacterial effect against Listeria monocytogenes during storage of carrots at 4 °C. Minicarrots were inoculated with L. monocytogenes at a final concentration of approximately 7 log CFU/g. Inoculated samples were coated by nisin at final concentration of 103 International Unit (IU)/mL or individual mountain savory EO or carvacrol at final concentration of 0.35%, w/w) or nisin + EO. The samples were then irradiated at 0, 0.5, and 1.0 kGy. The treated samples were kept at 4 °C and microbial analysis of samples were conducted at days 1, 3, 6, and 9. The results showed that coating carrots by carvacrol + nisin or mountain savory + nisin and then irradiating coated carrots at 1 kGy could reduce L. monocytogenes by more than 3 log at day 1 and reduced it to undetectable level from day 6.

Mycotoxins

Occurrence of Ochratoxin A Contamination and Detection of Ochratoxigenic Aspergillus Species in Retail Samples of Dried Fruits and Nuts

J.D. Palumbo, T.L. O'Keeffe, Y.S. Ho, C.J. Santillan

Journal of Food Protection, Vol. 78, No. 4; pp. 836–842

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Link to full text: Click here

Significance: Raisins are more frequently contaminated with low levels of ochratoxin A than other dried fruits and nuts, and Aspergillus species are the likely source of that contamination.

To determine the incidence of ochratoxin A (OTA) contamination in dried fruits and tree nuts, retail packaged and bulk raisins, dates, figs, prunes, almonds, pistachios, and walnuts were collected from small and large supermarkets in seven areas of the US between 2012 and 2014. Of the 665 samples analyzed, OTA was detected in 48 raisin samples, 4 fig samples, 4 pistachio samples, and 1 date sample, and ranged from 0.28 to 15.34 ng/g in dried fruits and 1.87 to 890 ng/g in pistachios; two raisin samples and one pistachio sample exceeded the European Union regulatory limit of 10 ng/g. PCR detection of potential OTA-producing Aspergillus species revealed the presence of A. niger, A. welwitschiae, and A. carbonarius in 20, 7, and 7 of the 57 OTA-contaminated samples, respectively. However, OTA-producing A. carbonarius was isolated from only one raisin sample.

Infant Formula

Exposure to Di-2-Ethylhexyl Phthalate, Di-N-Butyl Phthalate and Bisphenol A through Infant Formulas

T. Cirillo, G. Latini, M.A. Castaldi, L. Dipaola, E. Fasano, F. Esposito, et al.

Journal of Agricultural and Food Chemistry, Vol. 63, No. 12; pp. 3303–3310, 2015

doi: 10.1021/jf505563k

Link to full text: Click here

Significance: There are potential hazards for infants fed with baby formulas and the contamination seems more related to the production of formulas than to a release from containers.

The aim of this study was to test the presence of di-2-ethylhexyl phthalate (DEHP), di-n-butyl phthalate (DnBP), and bisphenol A (BPA) in infant formulas. DEHP, DnBP, and BPA concentrations were measured in 22 liquid and 28 powder milks by gas chromatography with flame ionization detection and high performance liquid chromatography with fluorimetric detection, respectively. DEHP concentrations were between 0.005 and 5.088 μg/g (median 0.906 μg/g), DnBP concentrations were between 0.008 and 1.297 μg/g (median 0.053 μg/g), and BPA concentrations were between 0.003 and 0.375 μg/g (median 0.015 μg/g). Concentrations of the investigated contaminants in liquid and powder milks were not significantly different, even though samples were packed in different types of containers.

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