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North America

Food Safety Briefs

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Listeria

Survival and Metabolic Activity of *Listeria monocytogenes* on Ready-to-Eat Roast Beef Stored at 4 °C

J.W. Broady II, D. Han, J. Yuan, C. Liao, C.L. Bratcher, M.R. Lilies, et al.

Journal of Food Science, Vol. 81, No. 7; pp. M1766–M1772

doi: 10.1111/1750-3841.13347

Link to full text: [Click here](#)

Significance: Antimicrobials cannot completely inhibit the growth of *L. monocytogenes* in ready-to-eat roast beef.

Three brands of commercial roast beef were purchased and artificially inoculated with a 5-strain *Listeria monocytogenes* cocktail at 2 inoculation levels (approximately 3 and 6 Log CFU/g). Although all 3 brands contained sodium diacetate and sodium lactate, inoculated *Listeria* cocktail survived for 16 d in all 3 brands. Significant increases in *L. monocytogenes* numbers were seen on inoculated Brand B roast beef on days 12 and 16. Numbers of *L. monocytogenes* increased to 4.14 Log CFU/g for the 3 Log CFU/g inoculation level and increased to 7.99 Log CFU/g for the 6 Log CFU/g inoculation level by day 16, with the pH values being 5.4 and 5.8, respectively. Brand B meat homogenate had the highest metabolic activities. By comparing its metabolic activities to Brands A and C and the inoculated autoclaved meat homogenates, results indicated that the microflora present in Brand B may be the reason for high metabolic activities. Brand B also had the highest microflora diversity (Shannon index 1.636 ± 0.011). Native microflora, product formula, pH, antimicrobial concentrations, and storage conditions may all impact the survival and growth of *L. monocytogenes*.

Listeria monocytogenes in Retail Delicatessens: An Interagency Risk Assessment—Risk Mitigations

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Journal of Food Protection, Vol. 79, No. 7; pp. 1076–1088

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Link to full text: [Click here](#)

Significance: The findings from this study are intended to encourage improvements in retail food safety practices and mitigation strategies to control *L. monocytogenes* in ready-to-eat foods more effectively.

This study illustrates the utility of a quantitative risk assessment model to evaluate the public health impact associated with changes in retail deli practices and interventions. Twenty-two mitigation scenarios were modeled and evaluated under six different baseline conditions. These scenarios were related to sanitation, worker behavior, use of growth inhibitors, cross-contamination, storage temperature control, and reduction of the level of *L. monocytogenes* on incoming ready-to-eat

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(RTE) food products. The mean risk per serving of RTE products obtained under these scenarios was then compared with the risk estimated in the baseline condition. Some risk mitigations had a consistent impact on the predicted listeriosis risk in all baseline conditions (e.g. presence or absence of growth inhibitor), whereas others were greatly dependent on the initial baseline conditions or practices in the deli (e.g. preslicing of products). Overall, the control of the bacterial growth and the control of contamination at its source were major factors of listeriosis risk in these settings.

Foodborne Pathogens

Salmonella and Escherichia coli O157:H7 Inactivation, Color, and Bioactive Compounds Enhancement on Raspberries During Frozen Storage After Decontamination Using New Formula Sanitizer Washing or Pulsed Light

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Journal of Food Protection, Vol. 79, No. 7; pp. 1107–1114

doi: 10.4315/0362-028X.JFP-15-379

Link to full text: [Click here](#)



Significance: Washing with a sanitizer or treatment with pulsed light could be used to process frozen raspberries for enhanced food safety and quality.

Washing berries with sanitizer and treatment with pulsed light (PL) were studied for their effectiveness to inactivate foodborne pathogens on raspberries during frozen storage, while maintaining or enhancing major quality parameters. Raspberries were inoculated with *Salmonella* or *Escherichia coli* O157:H7 and then underwent a washing treatment with citric acid plus sodium dodecyl sulfate (CA+SDS) or citric acid plus thymol (CA+THY) or treatment with PL (dry PL, water-assisted [wet] PL, and PL-SDS). Pathogen survival was determined immediately after treatments and during frozen storage at -20°C for 3 months. Washing with CA+SDS or CA+THY significantly reduced *Salmonella* and *E. coli* O157:H7. At the end of storage, washing with CA+SDS reduced *Salmonella* to 0.6 log CFU/g and *E. coli* O157:H7 to 0.5 log CFU/g; washing with CA+THY reduced *Salmonella* to 0.9 log CFU/g and *E. coli* O157:H7 to 0.5 log CFU/g. PL-SDS showed decontamination efficacy on raspberries, with 0.7 log CFU/g *Salmonella* and 0.9 log CFU/g *E. coli* O157:H7 surviving at the end of storage; in comparison, in the control, 1.6 log CFU/g *Salmonella* and 1.5 log CFU/g *E. coli* O157:H7 survived. Pathogen survival in raspberries that had been washed or treated with PL-SDS was significantly lower than in untreated raspberries. Washing with sanitizers and treatment with PL decreased the total bacterial count and total yeast and mold counts on raspberries and maintained the low counts.

Commercially Available Rapid Methods for Detection of Selected Food-borne Pathogens

W.B. Valderrama, E.G. Dudley, S. Doores, C.N. Cutter

Critical Reviews in Food Science and Nutrition, Vol. 56, No. 9; pp. 1519–1531

doi: 10.1080/10408398.2013.775567

Link to full text: [Click here](#)

Significance: This review describes the basic mechanism and capabilities of culture-dependent methods, discusses the difficulties of choosing the most convenient method, and provides an overview of the future challenges for the technology for rapid detection of microorganisms.

The enumeration and isolation of food-borne pathogens is performed using culture-dependent methods, which are sensitive, inexpensive, and provide both qualitative and quantitative assessment of the microorganisms present in a sample. However, these methods are time-consuming. Researchers are developing new techniques that allow detection of food pathogens in a shorter period of time. This review identifies commercially available methods for rapid detection and quantification of *Listeria monocytogenes*, *Salmonella* spp., *Staphylococcus aureus*, and Shiga toxin-producing *Escherichia coli* in food samples. Three categories are discussed: immunologically based methods, nucleic acid-based assays, and biosensors.

Molecular Detection of Foodborne Pathogens: A Rapid and Accurate Answer to Food Safety

M. Mangal, S. Bansal, S.K. Sharma, R.K. Gupta

Critical Reviews in Food Science and Nutrition, Vol. 56, No. 9; pp. 1568–1584

doi: 10.1080/10408398.2013.782483

Link to full text: [Click here](#)

Significance: This paper describes the conventional methods, as well as recent developments in food pathogen detection, identification, and quantification, with a major emphasis on molecular detection methods.

Food safety is a global health concern. For the prevention and recognition of problems related to health and safety, detection of foodborne pathogens is of utmost importance at all levels of food production chain. For several decades, a lot of research has been targeted at the development of rapid methodology as reducing the time needed to complete pathogen detection tests has been the primary goal of food microbiologists. With the result, food microbiology laboratories now have a wide array of detection methods and automated technologies such as enzyme immunoassay, polymerase chain reaction, and microarrays, which can cut test times considerably. Nucleic acid amplification strategies and advances in amplicon detection methodologies have been the key factors in the progress of molecular microbiology.

Salmonella

Cross-Laboratory Comparative Study of the Impact of Experimental and Regression Methodologies on Salmonella Thermal Inactivation Parameters in Ground Beef

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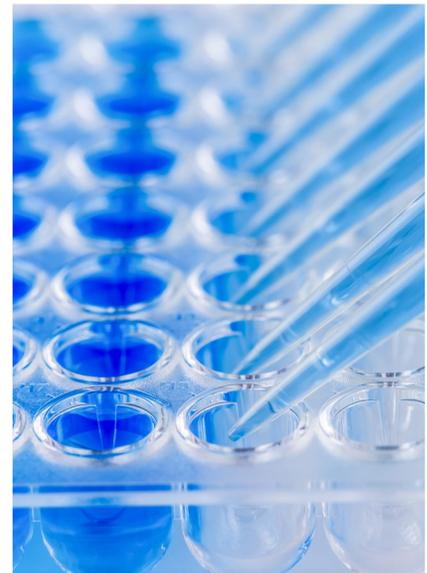
Journal of Food Protection, Vol. 79, No. 7; pp. 1097–1106

doi: 10.4315/0362-028X.JFP-15-496

Link to full text: [Click here](#)

Significance: Laboratory and regression methodologies have a large influence on resultant data and the subsequent estimation of thermal resistance parameters.

This study evaluated the effects of laboratory and regression methodologies on thermal inactivation data generation, interpretation, modeling, and inherent error, based on data generated from an experimental design that consisted of cross-laboratory comparison using two independent laboratories. Both laboratories conducted isothermal *Salmonella* inactivation studies (55, 60, 62°C) in ground beef, and each used two methodologies reported in prior studies. Two primary models



(log-linear and Weibull) with one secondary model (Bigelow) were fitted to the resultant data using three regression methodologies (two two-step regressions and a one-step regression). Results indicated that laboratory methodology impacted the estimated D 60°C- and z-values ($\alpha = 0.05$), with one laboratory's methodology yielding parameter estimates ~25% larger than the other one, regardless of the laboratory. Two-step regressions yielded root mean square error values on average 40% larger than the one-step regressions. The Akaike Information Criterion indicated the Weibull as the more correct model in most cases.

Inactivation of Salmonella on Sprouting Seeds Using a Spontaneous Carvacrol Nanoemulsion Acidified with Organic Acids

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Journal of Food Protection, Vol. 79, No. 7; pp. 1115–1126

doi: 10.4315/0362-028X.JFP-15-397

Link to full text: [Click here](#)

Significance: Acidified carvacrol nanoemulsion resulted in a final sprout product with no detectable pathogens, and total sprout yield was not influenced by any treatment.



This study examined the efficacy of an acidified carvacrol nanoemulsion tested against mung beans and broccoli seeds artificially contaminated with a *Salmonella enterica* Enteritidis cocktail (ATCC BAA-709, ATCC BAA-711, and ATCC BAA-1045). Treatments were performed by soaking inoculated seeds in acidified (50 mM acetic or levulinic acid) carvacrol nanoemulsions (4,000 or 8,000 ppm) for 30 or 60 min. After treatment, the number of surviving cells was determined via plate counts and/or the most probable number (MPN) approach. Treatment for 30 min successfully reduced *Salmonella* Enteritidis by 4 log CFU/g on mung beans (from an initial contamination level of 4.2 to 4.6 log CFU/g) and by 2 log CFU/g on broccoli seeds (from an initial contamination level of 2.4 to 2.6 log CFU/g) to below our detection limit (≤ 3 MPN/g). Treated seeds were sprouted and tested for the presence of pathogens and sprout yield.

Alternative Antimicrobial Commercial Egg Washing Procedures

L.K. Hudson, M.A. Harrison, M.E. Berrang, D.R. Jones

Journal of Food Protection, Vol. 79, No. 7; pp. 1216–1220

doi: 10.4315/0362-028X.JFP-15-423

Link to full text: [Click here](#)

Significance: Ambient temperature acidic washes reduced *Salmonella* contamination to the same degree as the standard pH 11 warm water wash and may be a viable option to reduce cost, increase shelf life, and slow pathogen growth in and on shell eggs.

Four wash procedures for commercial table eggs were evaluated for *Salmonella* reduction: pH 11 at 48.9°C (industry standard), pH 11 at ambient temperature (~20°C), pH 6 at 48.9°C, and pH 6 at ambient temperature. Alkaline washes contained potassium hydroxide-based detergent, while pH 6 washes contained approximately 200 ppm of chlorine and a proprietary chlorine stabilizer (T-128). When eggs were inoculated by immersion in a cell suspension of *Salmonella* Enteritidis and *Salmonella* Typhimurium, all treatments resulted in a slight and similar reduction of *Salmonella* numbers. When eggs were inoculated by droplet on the shell surface, *Salmonella* counts were reduced by approximately 5 log CFU when washed with chlorine plus the chlorine stabilizer at both temperatures and

with the alkaline wash at the high temperature. The reductions in Salmonella by these treatments were not significantly different from each other but were significantly more than the reduction observed for the 20°C alkaline treatment and 20°C control water treatments.

Higher Storage Temperature Causes Greater Salmonella enterica Serovar Typhimurium Internal Penetration of Artificially Contaminated, Commercially Available, Washed Free Range Eggs

A. Whiley, H. Fallowfield, K. Ross, V. McEvoy, H. Whiley

Journal of Food Protection, Vol. 79, No. 7; pp. 1247–1251

doi: 10.4315/0362-028X.JFP-16-078

Link to full text: [Click here](#)

Significance: Refrigeration reduced the potential for Salmonella Typhimurium to penetrate the eggshell membrane and internally contaminate table eggs.

This study explored the effect of temperature after 1, 7, 14, 21, and 28 days of storage on commercially available washed free range eggs, artificially contaminated with Salmonella Typhimurium on the external surface. At each time point, the external surface of the egg, the crushed eggshell, and the internal egg yolk and albumen were analyzed for Salmonella. After 28 days of storage, 25% of eggs stored at 4°C, 50% of eggs stored at 14°C, and 100% of eggs stored at 23 and 35°C were internally contaminated with Salmonella. After 1 day of storage, more than 50% of all eggs had Salmonella present in the crushed shell after the external surface had been disinfected with ethanol.

Modelling Salmonella Transmission Among Pigs From Farm to Slaughterhouse: Interplay Between Management Variability and Epidemiological Uncertainty

J.F. Savall, C. Bidot, M. Leblanc-Maridor, C. Belloc, S. Touzeau

International Journal of Food Microbiology, Vol. 229, 16 July 2016; pp. 33–43

doi: 10.1016/j.ijfoodmicro.2016.03.020

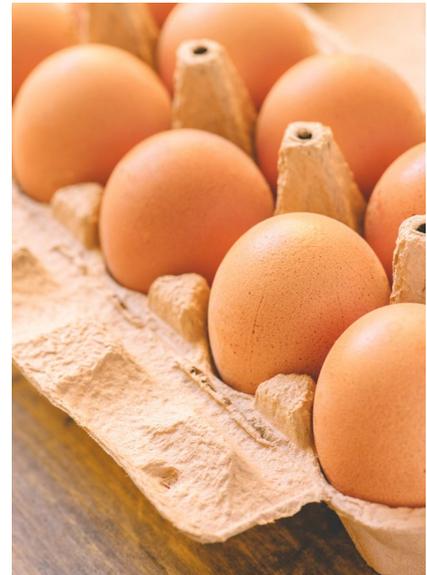
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Significance: Re-excretion of carriers due to stress does not have a major impact on the number of new infections.

To better understand and potentially control what influences Salmonella transmission within a pig batch from farm to slaughterhouse and lairage step, this study proposed a compartmental, discrete-time and stochastic model. The model was calibrated using pork chain data and a sensitivity analysis was carried out to evaluate the impact of the variability in management protocols and of the uncertainty in epidemiological parameters on three model outcomes: prevalence of infection, average cutaneous contamination and number of new infections at slaughter. Each outcome was mainly influenced by a single management factor: prevalence at slaughter mainly depends on the prevalence at farm, cutaneous contamination on the contamination of lairage pens and new infections on the total duration of transport and lairage.

E. coli

Efficacy of Slightly Acidic Electrolyzed Water and UV-Ozonated Water Combination for Inactivating Escherichia Coli O157:H7 on Romaine and Iceberg Lettuce During Spray Washing Process



Y-H. Pang, Y-C. Hung Close

Journal of Food Science, Vol. 81, No. 7; pp. M1743–M1748

doi: 10.1111/1750-3841.13364

Link to full text: [Click here](#)

Significance: The combined treatment of slightly acidic electrolyzed water and ultraviolet-ozonated water in the spray washing process could more effectively reduce *E. coli* O157:H7 on lettuce, which in turn may help reduce incidences of *E. coli* O157:H7 outbreaks.

The purpose of this research was to investigate the antimicrobial effect of spraying slightly acidic electrolyzed water (SAEW) and a combination of ozonated water with ultraviolet (UV) in reducing *Escherichia coli* O157:H7 on romaine and iceberg lettuces. Both romaine and iceberg lettuces were spot inoculated with 100 µL of a 3 strain mixture of *E. coli* O157:H7 to achieve an inoculum of 6 log CFU/g on lettuce. A strong antimicrobial effect was observed for the UV-ozonated water combination, which reduced the population of *E. coli* by 5 log CFU/g of *E. coli* O157:H7 on both lettuces. SAEW achieved about 5 log CFU/g reductions in the bacterial counts on romaine lettuce. However, <2.5 log CFU/g in the population of *E. coli* O157:H7 was reduced on iceberg lettuce. The difference may be due to bacteria aggregation near and within stomata for iceberg lettuce but not for romaine lettuce. The UV light treatment may stimulate the opening of the stomata for the UV-ozonated water treatment and hence achieve better bacterial inactivation than the SAEW treatment for iceberg lettuce.



Changes in Aerobic Plate and *Escherichia coli*–Coliform Counts and in Populations of Vegetables and Restaurant Salads as a Reservoir for Shiga Toxigenic *Escherichia coli*: Distribution of Virulence Factors, O-Serogroups, and Antibiotic Resistance Properties

A. Shakerian, E. Rahimi, P. Emad

Journal of Food Protection, Vol. 79, No. 7; pp. 1154–1160

doi: 10.4315/0362-028X.JFP-15-517

Link to full text: [Click here](#)

Significance: The importance of vegetables and salads as potential sources of *E. coli* infection are highlighted in this study.

The distribution of virulence factors, O-serogroups, and antibiotic resistance properties in Shiga toxigenic *Escherichia coli* (STEC) isolated from vegetables and salads was examined. Samples of vegetables and salad (n=420) were collected and evaluated for the presence of *E. coli* using culture and a PCR assay. *E. coli* was found in 49.6% of vegetable samples and 49% of salad samples. Leek and traditional salad had the highest incidence of *E. coli*. Significant differences in the incidence of *E. coli* were found between the hot and cold seasons. Of the 149 *E. coli* isolates from vegetable samples, 130 (87%) were STEC, and of the 59 *E. coli* isolates from salad samples, 50 (84%) were STEC. The most commonly detected virulence factors were stx 1 and eaeA. A significant difference was found between the frequency of the attaching and effacing and the enterohemorrhagic *E. coli* subtypes. Serogroups O26 (46% of isolates), O157 (14%), O121 (10%), and O128 (9%) were the most commonly detected serogroups among the STEC strains. The tetA, sul1, aac(3)-IV, dfrA1, blaSHV, and CITM antibiotic resistance genes were found in 96, 47.7, 90, 51, 27, and 93% of isolates, respectively. The highest levels of resistance were found against ampicillin (96.6% of isolates), tetracycline (87%), and gentamicin (90%).

Investigating Metrics Proposed to Prevent the Harvest of Leafy Green Crops Exposed to Floodwater Contaminated with *Escherichia coli*

M.T. Callahan, S.A. Micallef, M. Sharma, P.D. Millner, R.L. Buchanan

Applied and Environmental Microbiology, Vol. 82, No. 13; pp. 3746–3753

doi: 10.1128/AEM.00052-16

Link to full text: [Click here](#)

Significance: The current Leafy Green Products Handler Marketing guidelines should be revised to include considerations of field and weather conditions that may promote bacterial movement and survival.

In this study, the suitability of the Leafy Green Products Handler Marketing Agreement (LGMA) metrics for farms in the Mid-Atlantic region of the United States was evaluated. The upper end of a spinach bed established on a –5% grade was flooded with water containing 6 log CFU/ml *Escherichia coli* to model a worst-case scenario of bacterial movement through soil. *E. coli* prevalence in soil and on foliar tissue was determined by most probable number (MPN) analysis at distances up to 9 m from the edge of the flood for 63 days. While *E. coli* was quickly detected at the 9-m distance within 1 day in the spring trial and within 3 days in the fall trial, no *E. coli* was detected on plants outside the flood zone after 14 days. On day 63 for the two trials, *E. coli* populations in the flood zone soil were higher in the fall than in the spring. Regression analysis predicted that the time required for a 3-log MPN/g (dry weight) decrease in *E. coli* populations inside the flood zone was within the 60-day LGMA guideline in the spring but would require 90 days in the fall.

Effect of Relevant Environmental Stresses on Survival of Enterohemorrhagic *Escherichia coli* in Dry-Fermented Sausage

A. McLeod, I. Måge, E. Heir, L. Axelsson, A.L. Holck

International Journal of Food Microbiology, Vol. 229, 16 July 2016; pp. 15–23

doi: 10.1016/j.ijfoodmicro.2016.04.005

Link to full text: [Click here](#)

Significance: The importance of vegetables and salads as potential sources of *E. coli* infection are highlighted in this study.

Adaptation of enterohemorrhagic *Escherichia coli* (EHEC) to acid, salt and low temperatures prior to being introduced in a dry-fermented sausages production process has limited, but strain dependent effects on EHEC reductions.

This study exposed two enterohemorrhagic *Escherichia coli* (EHEC) strains, MF3582 of serotype O157:H – and MF5554 of serogroup O145, to different stresses commonly encountered during a production process. The two EHEC strains were subjected to low temperatures (4 °C and 12 °C), 5% NaCl or 1% lactic acid for 6 days prior to being added to sausage batters. Survival of EHEC was recorded in salami of two recipes, fermented at two temperatures (20 °C and 30 °C). The results showed that recipe type had the largest impact on EHEC reductions where moderate recipe (MR) salami batters containing increased levels of NaCl, glucose and NaNO₂ provided enhanced EHEC reductions in salami (2.6 log₁₀) compared to standard recipe (SR) salami (1.7 log₁₀). Effects of pre-exposure stresses were dependent both on strain and recipe. While acid adaptation of MF5554 provided enhanced log₁₀ reductions from 2.0 to 3.0 in MR sausages, adaptation to a combination of acid and salt stress showed the opposite effect in SR sausages with reductions of only 1.1 log₁₀ as compared to the average of 1.8 log₁₀ for the other SR



sausages. Growing cells and cells frozen in batter survived poorly in MR sausages with an average reduction of 3.4 and 3.2 log₁₀, respectively.

Food Allergy

Food Allergens: Is There a Correlation Between Stability to Digestion and Allergenicity?

KL. Bøgh, C.B. Madsen

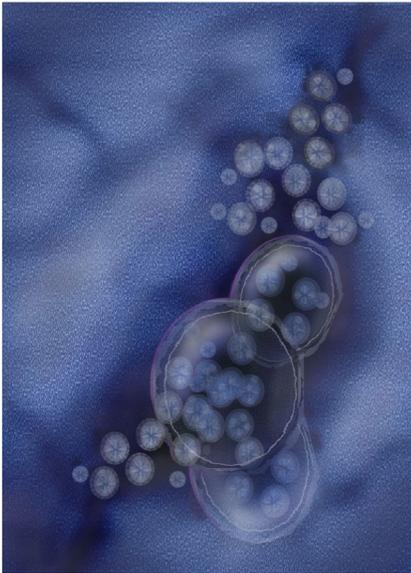
Critical Reviews in Food Science and Nutrition, Vol. 56, No. 9; pp. 1545–1567

doi: 10.1080/10408398.2013.779569

Link to full text: [Click here](#)

Significance: Digestion may abolish, decrease, have no effect, or even increase the allergenicity of food allergens.

Food allergy is a major health problem in the Western countries, affecting 3–8% of the population. It has not yet been established what makes a dietary protein a food allergen. Several characteristics have been proposed to be shared by food allergens. One of these is resistance to digestion. This paper reviews data from digestibility studies on purified food allergens and evaluates the predictive value of digestibility tests on the allergenic potential. Food allergens do not necessarily resist digestion. The choice of in vitro digestibility assay condition and the method used for detection of residual intact protein are discussed as well as fragments hereof may greatly influence the outcome and interpretation of results. The finding that digests from food allergens may retain allergenicity, stresses the importance of using immunological assays for evaluating the allergenic potential of food allergen digestion products.



Norovirus

Persistence and Elimination of Human Norovirus in Food and on Food Contact Surfaces: A Critical Review

N. Cook, A. Knight, G.P. Richards

Journal of Food Protection, Vol. 79, No. 7; pp. 1273–1294

doi: doi.org/10.4315/0362-028X.JFP-15-570

Link to full text: [Click here](#)

Significance: Thorough washing of herbs and produce was effective in reducing, but not eliminating, norovirus (NoV) in most products, but washing hands with soap generally reduced NoV by <2 log.

This critical review addresses the persistence of human norovirus (NoV) in water, shellfish, and processed meats; on berries, herbs, vegetables, fruits, and salads; and on food contact surfaces. It also addresses NoV elimination or inactivation by various chemical, physical, or processing treatments. NoV persisted for 60 to 728 days in water, depending on water source. It also persisted on berries, vegetables, and fruit, often showing <1-log reduction within 1 to 2 weeks. NoV was resilient on carpets, Formica, stainless steel, polyvinyl chloride, and ceramic surfaces; during shellfish depuration; and to repeated freeze-thaw cycles. Copper alloy surfaces may inactivate NoV by damaging viral capsids. Disinfection was achieved for some foods or food contact surfaces using chlorine, calcium or sodium hypochlorite, chlorine dioxide, high hydrostatic pressure, high temperatures, pH values >8.0, freeze-drying, and UV radiation. Ineffective disinfectants included hydrogen

peroxide, quaternary ammonium compounds, most ethanol-based disinfectants, and antiseptics at normally used concentrations.

Evaluation of Viability PCR Performance for Assessing Norovirus Infectivity in Fresh-Cut Vegetables and Irrigation Water

W. Randazzo, F. López-Gálvez, A. Allende, R. Aznar, G. Sánchez

International Journal of Food Microbiology, Vol. 229, 16 July 2016; pp. 1–6

doi: 10.1016/j.ijfoodmicro.2016.04.010

Link to full text: [Click here](#)

Significance: The pretreatment used in this study has the potential to be integrated in routine diagnoses to improve the interpretation of positive norovirus results obtained by quantitative RT-PCR.

Initially, conventional photoactivatable dyes (i.e. propidium monoazide [PMA] and ethidium monoazide [EMA]) and newly developed ones (i.e. PMAxx and PEMAX) were evaluated for the discrimination between infectious and thermally inactivated norovirus (NoV) genogroup I (GI) and II (GII) suspensions. Results showed that PMAxx was the best photoactivatable dye to assess NoV infectivity. This procedure was further optimized in artificially inoculated lettuce. Pretreatment with 50 μ M PMAxx and 0.5% Triton X-100 (Triton) for 10 min reduced the signal of thermally inactivated NoV by ca. 1.8 logs for both genogroups in lettuce concentrates. Additionally, this pretreatment reduced the signal of thermally inactivated NoV GI between 1.4 and 1.9 logs in spinach and romaine and lamb's lettuces and by > 2 logs for NoV GII in romaine and lamb's lettuce samples. This pretreatment was satisfactorily applied to naturally-contaminated water samples with NoV GI and GII.

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