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Antimicrobials Used to Battle *E.coli* O157:H7 Also Effective at Destroying nSTEC, AMIF Studies Find

Current antimicrobial compounds used by meat industry to destroy *E. coli* O157:H7 are effective against non-O157 STEC, according to an AMIF-funded study conducted by researchers at the Agricultural Research Service's Meat Animal Research Center.

Researchers evaluated the efficacy of six commonly used antimicrobials on *Escherichia coli* O157:H7 and non-O157 shiga toxin-producing *E. coli* (STEC) serogroups O26, O103, O111 and O145 on beef. The antimicrobial compounds used were acidified sodium hypochlorite, peroxyacetic acid, FreshFx, lactic acid, activated hydrobromic acid and hot water.

The degree of effectiveness depended on the antimicrobial compounds used. Hot water was the most effective in reducing pathogens tested followed by lactic acid. Acidified sodium chlorite and activated hydrobromic acid showed less immediate effect, but increased effectiveness after chilling for 48 h at 4°C.

Despite the reduced effect of these antimicrobial compounds, the recovery of these pathogens with low inoculation levels indicated that one of the following possibilities could occur: (a) the solutions might not be applied uniformly all of the surfaces since carcasses have irregular shapes and surfaces causing

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AMIF Study Examines *Listeria* Resistance Development

AMIF-funded research conducted at North Carolina State University explored the adaptations and mechanisms that *Listeria monocytogenes* employs to colonize in ready-to-eat meat and poultry processing plants.

The objectives of the project were to: characterize genetic and molecular mechanisms mediating resistance of *L. monocytogenes* to quaternary ammonium disinfectants; characterize genetic and molecular mechanisms responsible for temperature-dependent resistance of *L. monocytogenes* epidemic clone II strains to phage; and assess growth of different strains of *L. monocytogenes* and of *Listeria* spp. on ready-to-eat meat of different origin (chicken, turkey, beef).

Genetic analysis revealed that a gene cassette (*bcrABC*) first identified on a large plasmid (pLM80) harbored by strains implicated in the 1998-1999 hot dog outbreak conferred resistance to benzalkonium chloride (BC) and other quaternary ammonium disinfectants to *L. monocytogenes*. Transcription of the genes was induced by BC and expression was significantly

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▶ FOOD SAFETY SPOTLIGHT

E. coli O157:H7 Functions as Indicator Organism for Non-O157

Recently, there has been an increased focus on non-O157 STEC and their impact on food safety. The following analysis, prepared by AMIF's Director of Scientific Affairs Betsy Booren, Ph.D., seeks to evaluate and clarify the science behind using *E. coli* O157:H7 as an indicator organism for nSTEC in ground beef:

The meat industry has long recognized that shiga toxin-producing *Escherichia coli* (STEC), including non-O157:H7 STEC (nSTEC), have the potential to cause illness in humans under the right conditions. Using Centers for Disease Control and Prevention (CDC) data, the Food Safety and Inspection Service (FSIS) has specifically identified the following nSTEC as causes for concern in ground beef products and the components that make up ground beef products: O26,

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Food Safety Spotlight: *E. coli* O157:H7 Effective Indicator Organism for nSTEC

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O111, O103, O45, O145, and O121. On September 20, FSIS issued a *Federal Register* Notice making six additional STEC (the top 6) adulterants in certain ground beef products effective March 2012.

Process management systems are used by the beef industry to assess the adequacy of control within a food safety program using microbiological monitoring and are used to make decisions in mitigating the risk of *E. coli* O157:H7 on beef products. To address the potential risk of STEC contamination within the beef supply, the beef industry should employ a process management system that addresses all STEC, which includes using *E. coli* O157:H7 as an indicator organism. Given the history of STEC outbreaks and the industry's success in reducing *E. coli* O157:H7 prevalence in beef products, *E. coli* O157:H7 is likely the best microorganism to target in reducing the risk when consuming beef products as the number of confirmed illnesses within the U.S. have been more attributed to *E. coli* O157:H7 than to nSTEC (CDC, 2011).

FSIS in the August 2011 issue of the *Journal of Food Protection* published a review examining the role of indicator organisms in meat and poultry slaughter operations for use in process control (Saini et al., 2011). Saini and others (2011) stated that indicator organisms "are those organisms whose presence in numbers above certain limits indicates inadequate processing for ensuring that pathogens would not be present or would be present in small numbers, assuming the organism was present, at possibly high levels, before the processing step of concern." Index organisms are organisms "whose presence in numbers above certain limits indicates the possible presence of ecologically similar pathogen" (Saini et al., 2011). As an establishment examines how to develop or reassess a food safety process management system, it is necessary to identify index and indicator organisms that correlate to targeted pathogen hazards when determining process control factors.

When a beef establishment is trying to address not only the adulteration status of *E. coli* O157:H7 for ground beef products and the components that comprise ground

beef products, but also the contamination risk of all STEC, delineation is difficult. In the current regulatory ideology, *E. coli* O157:H7 can be identified as both the index organism and indicator organism for the target STEC pathogens in beef establishments.

Using the definition of Saini et al. (2011), *E. coli* O157:H7 is a logical index organism for nSTEC in ground beef products and the components that make up ground beef products. This is supported by the fact that *E. coli* O157:H7 and nSTEC outbreaks follow the typical beef seasonal pattern with increased incidences associated with summer months (Mody and Luna, 2011). Notwithstanding, it is also not uncommon for multiple etiology outbreaks to occur among nSTEC (Mody and Luna, 2011), which is logical as STEC microorganisms originate from the same source and sources of contamination are the same within the food production chain.

E. coli O157:H7 also meets the qualifications as an indicator organism for STEC in ground beef products and the components that make up ground beef products. As stated above, both *E. coli* O157:H7 and nSTEC during the production of ground beef products and the components that make up ground beef products originate from the same source – the beef animal. During the slaughter process, the nSTEC follow the same vectors of contamination transfer, *i.e.* hides, hooves, rumen contents, as *E. coli* O157:H7 (Barkocy-Gallagher et al., 2011). A robust *E. coli* O157:H7 food safety process management sampling program, *i.e.* N60-Trim, is currently used by beef establishments to assess multiple-hurdle intervention capabilities and individual plant performance, as well as providing valuable historical baseline data for trend analysis and continuous plant improvement.

These types of robust sampling plans for *E. coli* O157:H7 are effective and would continue to be effective if *E. coli* O157:H7 was an indicator organism for nSTEC contamination, since it would as Saini et al. (2011) stated "(i) give an understanding of how the indicator organism's presence at high levels reflects probable process deficiencies;

(ii) acceptance that actions to improve the process may eliminate or reduce the number of indicator organisms; and (iii) that said actions could affect the levels or presence of pathogens." The meat and poultry industry has initiated research to show that process control management systems currently employed are effective against STEC as the originating source of the contamination is the same as *E. coli* O157:H7 (Geornaras et al., 2011; Kalchayanand et al., 2011a; Kalchayanand et al., 2011b; Pohlman et al., 2011). These types of research demonstrate, assuming a failure in a food safety process control, not only higher levels of *E. coli* O157:H7 would indicate the possibility of greater incidence of nSTEC, but also any corrective actions effective for *E. coli* O157:H7 would also be effective for nSTEC.

The beef industry has a long history of controlling and measuring *E. coli* O157:H7 in ground beef products and the components that make up ground beef products, which provides the industry, as defined by Saini and others (2011), the critical information needed during the selection of the indicator organism such as the prevalence of the indicator, ease of finding the indicator as well as its purpose of use and the correlation between the indicator and targeted pathogen growth and inactivation kinetics (Anonymous, 2011; Arthur et al., 2002; Bosilevac et al., 2011; Luchansky et al., 2011a, Luchansky et al., 2011b; Vasan et al., 2011).

The use of *E. coli* O157:H7 as an indicator organism for nSTEC is logical as there are similar causes within the production of ground beef products and the components that make up ground beef products that affect the prevalence of these organisms and these organisms can be similarly identified and controlled. Using *E. coli* O157:H7 as a metric within a food safety process control management system, *i.e.* N60-Trim or similar robust sampling programs, can demonstrate that the food safety process can be improved over time, identify any event or loss of process control situations, and support that any corrective actions decisions have decreased not only *E. coli* O157:H7 but also the targeted nSTEC pathogens.

AMIF Research Examines *Listeria* Resistance Mechanisms

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higher at low temperature (4, 8, 25°C) than at 37°C. This cassette has become disseminated among different strains and serotypes of *L. monocytogenes*. A gene cassette unique to *L. monocytogenes* ECII was found to be responsible for the remarkable ability of these strains to resist phage infection when grown at low temperatures.

The mechanism appears to involve the digestion of phage DNA upon injection into ECII cells via a temperature-regulated enzyme, encoded by one of the ECII-unique genes. Growth of *Listeria* on ready to eat deli meat (bologna) was not impacted by resistance to BC and was similar for *L. monocytogenes* and *L. innocua*. However, growth was more pronounced on chicken bologna than on turkey or beef.

The current status report for this project can be read at <http://amif.org/ht/a/GetDocumentAction/i/49632>.

FDA Establishes Response Network to Manage Outbreaks

The Food and Drug Administration (FDA) recently announced a new Coordinated Outbreak Response and Evaluation (CORE) Network to manage outbreak responses as well as surveillance and post-response activities related to illness outbreaks caused by FDA-regulated human and animal food and cosmetic products.

The goal of the CORE Network is the strengthen FDA's efforts to prevent, detect, investigate, respond to and learn from incidents and outbreaks.

CORE will have a full time staff which will allow for improved incident response times and standardized procedures. CORE will be led by the Chief Medical Officer/Outbreak Director who will have overall responsibility for leadership and management of FDA's activities related to illnesses linked to human and animal foods. Other staff positions within CORE are responsible for strategic planning during outbreak response as well as outbreak preparedness, surveillance, response and post-response activities. More information on the CORE Network is available at <http://www.fda.gov/Food/FoodSafety/CORENetwork/default.htm>.

Antimicrobials Used to Destroy *E. coli* O157:H7 Also Effective Against nSTECs

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over-exposed to the treatment on one part and under-exposed on the other; (b) even with a uniform spray, all antimicrobial compounds will not only inactivate the bacterial cells, but also inflict sublethal injury to the cells. At a suitable environment, sublethally injured cells repair their injury, gain their normal characteristics, and subsequently initiate multiplication."

The report can be read at <http://www.amif.org/ht/a/GetDocumentAction/i/70695>.

A complementary AMIF study by the same research team evaluated the efficacy of those same six antimicrobials on non-O157 STEC O45, O121 and non- and multi-drug resistant *Salmonella* strains.

The final report provides a similar conclusion, noting that all antimicrobial compounds used by the beef industry were effective against non-O157 STEC and *Salmonella*.

The reductions of these pathogens on inoculated fresh beef with tested compounds in general, were as effective against non-O157 STEC as *E. coli* O157:H7. The degree of effectiveness again depended on the antimicrobial compounds used. In this study, lactic acid, hot water, and acidified sodium chlorite were more effective in reducing pathogens. FreshFx had an intermediate effect, while peroxyacetic acid and BoviBrom had the least effect. The effectiveness of these compounds on non-MDR and MDR was inconclusive and possibly strain dependent, but Typhimurium were more resistant than Newport. Despite the reduced effect of these antimicrobial compounds, the recovery of these pathogens with low inoculation levels indicated that one of the following possibilities could occur: (a) the solutions might not be applied uniformly to all of the

surfaces as carcasses have irregular shapes and surfaces causing over-exposure to the treatment on one part and under-exposure on others; (b) even with a uniform spray, all antimicrobial compounds will not only inactivate the bacterial cells, but also inflict sublethal injury to the cells. An enumeration with selective medium may overestimate effects of the antimicrobial interventions used. It should be noted that in a suitable environment, sublethally injured cells may repair their injury, gain their normal characteristics, and subsequently initiate multiplication.

The final report is available at <http://amif.org/ht/a/GetDocumentAction/i/72853>.

Additional AMIF-funded research was recently conducted by Colorado State University to determine whether interventions known for reducing *E. coli* O157:H7 contamination on beef trimmings are also effective in reducing non-O157 STEC, and multiple drug resistant (MDR) and susceptible *Salmonella* Newport and *Salmonella* Typhimurium. The interventions evaluated were lactic acid, acidified sodium chlorite, peroxyacetic acid, sodium metasilicate, Bromitize® Plus, SYNTRx 3300 and AFTEC 3000.

Findings indicated that the antimicrobial effects of these decontamination treatments against the non-O157 STEC serotypes and *S. Newport*/Typhimurium antibiotic resistance phenotypes were generally the same as those against *E. coli* O157:H7.

The final report is available at <http://www.amif.org/ht/a/GetDocumentAction/i/72071>.

Poll: Many U.S. Adults Unaware of Key Food Safety Practices

A new poll commissioned by the American Meat Institute (AMI) and conducted by Harris Interactive found that while almost nine out of 10 U.S. adults (88 percent) cook hamburgers or poultry (chicken or turkey) burgers, only 19 percent of those who do use an instant read thermometer to determine that the burgers are safely cooked and ready to eat (i.e., “doneness”). Approximately 73 percent of adults who cook hamburgers or poultry burgers incorrectly rely on sight to determine doneness and 57 percent incorrectly rely on cooking time.

Of concern: only 13 percent of adults aged 18-34 who cook hamburgers or poultry burgers, many of whom may prepare food for small children at home, use an instant read thermometer to determine doneness when cooking hamburgers or poultry burgers. Seventy-eight percent of this age group rely on sight,

► AMIF RESEARCH

AMIF Study Validates Quaternary Ammonia and Hydrogen Peroxide Powder *Lm* Control

A validation of quaternary ammonia and hydrogen peroxide powder for controlling *Listeria monocytogenes* in ready-to-eat meat and poultry processing facilities was recently conducted by the Silliker Inc., Food Science Center.

This AMIF-funded study, conducted in two phases, first examined inactivation of *L. monocytogenes* by dry quaternary ammonia and hydrogen peroxide then examined inactivation at different moisture levels.

The objective of Phase I of these experiments was to understand the effectiveness of dry powdered quaternary ammonia and hydrogen peroxide to inactivate *L. monocytogenes* levels on clean and soiled floor tiles. The fundamental questions addressed include: How long does it take the chemical to react with the microorganism and inactivate it; and is the chemical effective on soiled surfaces; and is 1,000 ppm adequate to kill all *Listeria* on a surface?

Researchers found that the survival of *L. monocytogenes* on the floor tiles was influenced by the presence of organic components. Quaternary ammonia was not effective against *L. monocytogenes* on clean or soiled dry surfaces, while hydrogen peroxide was effective against *L. monocytogenes* on clean or soiled dry surfaces.

The objective of Phase II experiments was to understand the effectiveness of powdered quaternary ammonia and hydrogen peroxide to inactivate *L. monocytogenes* on clean and soiled floors at two moisture levels. The fundamental question to be answered was: is the dry chemical effective, or does it require water/moisture in order to work?

Results from Phase 2 showed quaternary ammonia was influenced by moisture. It required moisture to become effective against *L. monocytogenes* and its efficacy increased with an increase in moisture level. The efficacy of hydrogen peroxide was more significant in the presence of moisture. Overall, hydrogen peroxide was more effective against *L. monocytogenes* under similar conditions compared to quaternary ammonia.

The final report is available at <http://www.amif.org/ht/a/GetDocumentAction/i/71609>.

which is not an accurate indicator of doneness, to determine if the burger is cooked properly.

In terms of proper cooking temperatures, only one in five U.S. adults (20 percent) knows a hamburger should be cooked to 160 degree F to ensure it is safe to consume, while 41 percent mistakenly believe that hamburgers should be cooked to a temperature less than 160 degrees F, according to the poll.

Nearly half of U.S. adults (47 percent) believe that poultry burgers should be cooked to a temperature less than 165 degrees F. Only 13 percent know that a poultry burger should be cooked to 165 degree F to ensure it is safe to consume.

For more information and additional resources to safely prepare meat and poultry visit <http://www.meatsafety.org/>.

AMIF Study: Stressed *Listeria monocytogenes* Form Filaments That Can Enhance Survival

Certain stresses encountered by *L. monocytogenes* in the ready-to-eat (RTE) meat processing environment induce filamentation, which contributes to the pathogen’s survival in the food processing environment and enhances its virulence potential, a University of Wisconsin study found.

The AMIF-funded research concluded that *L. monocytogenes* develops filaments when exposed to osmotic stress induced by low water activity. When the stress was removed, the filaments septated and divided into normal-sized cells at 30°C and 4°C, leading to an increase in bacterial numbers more quickly than control (non-filamented) cells. The relative ability of filaments and control cells to survive stresses commonly encountered in the RTE meat environment varied depending on the stress and exposure time.

Filaments were less sensitive than control cells to acid (pH 2) and drying on a stainless steel surface, but survival was similar at high temperature (55°C). Three sanitizers tested were all effective against both filaments and control cells. *L. monocytogenes* did not grow or develop filaments on three types of luncheon meat tested; however, there was a significant decrease in viability on pepperoni, which had the lowest water activity.

Control cells and filaments decreased in viability to a similar extent when exposed to either nitrite or a nisin/rosemary extract blend. Both control cells and filaments increased in viable numbers in diacetate/lactate, with greater increases in the filament culture, while in sodium hexametaphosphate, the viable control cell number generally decreased but that of filaments increased. Overall, exposure to luncheon meats or an antimicrobial appeared to prolong the persistence of the filamentous phenotype.

The final report is available at <http://www.amif.org/ht/a/GetDocumentAction/i/71607>.

CDC Releases Data on 2008 Foodborne Disease Outbreaks

The Centers for Disease Control and Prevention (CDC) published *Surveillance for Foodborne Disease Outbreaks – United States, 2008* in the September 9 *Morbidity and Mortality Weekly Report*. CDC collects and reports data on foodborne disease outbreaks reported by states and territories through the Foodborne Diseases Outbreak Surveillance System. This report attributes illnesses due to outbreaks with etiological agents.

In 2008, there were 1,034 foodborne disease outbreaks with 23,152 illnesses resulting in 22 deaths. Six percent (1,276) of outbreak related illnesses resulted in hospitalizations. *Salmonella* caused of 62 percent of the hospitalizations followed by shiga toxin-producing *E. coli* (STEC) with 17 percent and norovirus with 7 percent. Hospitalizations due to illnesses caused by *Clostridium botulinum* occurred 90 percent of the time followed by *Listeria* 76 percent of the time. Of the 22 deaths, 20 were caused by bacterial etiologies, and one each by norovirus and mycotoxin. Among the 20 deaths due to bacterial etiologies, 13 were caused by *Salmonella*, three by *Listeria monocytogenes*, two by STEC O157, one by STEC O111 and one by *Staphylococcus*

Of the 479 outbreaks with a confirmed single etiologic agent, norovirus accounted for 49 percent of outbreaks and 46 percent of illnesses followed by *Salmonella* with 23 percent of outbreaks and 31 percent of illnesses. Among the 218 outbreaks attributed to only one of 17 defined food commodities, poultry accounted for 15 percent of the outbreaks and beef and finfish for 14 percent each. The three commodities linked to outbreak related illnesses are fruit and nuts (24 percent), vine-stalk vegetables (23 percent) and beef (13 percent). The pathogen-commodity pairs attributed to the most outbreaks were norovirus in leafy vegetables (18), ciguatoxin in finfish (14), STEC O157 in beef (12) and *Salmonella* in poultry (11). The pathogen commodity pairs linked with the most illnesses are *Salmonella* in vine-stalk vegetables (1,604) and *Salmonella* in fruits-nuts (1,401).

The full report is available at http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6035a3.htm?s_cid=mm6035a3_w.

FDA Announces Retail Food Safety Action Plan

The U.S. Food and Drug Administration (FDA) recently announced a Retail Food Safety Action Plan that calls for new state and local food safety requirements for retail food establishments and for training for personnel on food safety measures.

Key changes to 2009 Food Code recommendations contained in the new supplement include:

- Requiring that food establishments have a certified food protection manager on staff;
- New established duties of the person-in-charge;
- Requiring that food establishments have a plan for responding to and properly cleaning-up after an employee or other individual becomes physically ill in areas where food may be prepared, stored or served;
- Clarifying appropriate exceptions to the prohibition of bare hand contact with ready-to-eat foods prepared in the establishment;
- Clarifying the requirements for the safe storage and display of ground and whole-muscle meat and poultry;
- New requirements for devices used to generate chemical sanitizers on-site in the food establishment;
- Establishing clearer guidelines for the amount time a food establishment should be given to correct violations of different types of provisions in the Food Code.

For more information on the new recommendations, go to <http://www.fda.gov/Food/FoodSafety/RetailFoodProtection/FoodCode/FoodCode2009/ucm272584.htm>.

Agencies Seek Info On Strategies for Reducing Dietary Intake of Sodium

The Food Safety and Inspection Service (FSIS) and the Food and Drug Administration (FDA) announced in the *Federal Register* a call for comments, data and evidence relevant to the dietary intake of sodium, as well as current and emerging approaches designed to promote sodium reduction.

FSIS/FDA stated that research shows that excess sodium consumption is a contributory factor in the development of hypertension, which is a leading cause of heart disease and stroke, the first and fourth leading causes of death in the United States, respectively. Also referenced is “over three-quarters of sodium in the diet of the U.S. population is added during manufacturing of foods and preparation of restaurant foods, reduction in sodium consumption in the United

States involves reduction in the sodium content of food in the U.S. marketplace.”

The agencies are seeking information and data to better inform them about current and emerging practices by the private sector in sodium reduction; current consumer understanding of the role of sodium in hypertension and other chronic illnesses; sodium consumption practices; motivation and barriers in reducing sodium in their food intakes; and issues associated with the development of targets for sodium reduction in foods to promote reduction in excess sodium intake.

FSIS/FDA recognized that other sodium compounds — sodium phosphates, sodium nitrites, sodium lactate, etc., in addition to sodium chloride are added to foods, and are also of interest to them.

The *Federal Register* announcement

can be viewed here: <http://www.fsis.usda.gov/OPPDE/rdad/FRPubs/2011-0014.pdf>. Comments and data will be accepted until November 29, 2011.

As part of these dockets, FSIS and FDA, along with the Centers for Disease Control and Prevention, Agricultural Research Service and Center for Nutrition Policy and Promotion, will hold a public meeting on approaches to reducing sodium consumption on November 10. Additional information on the meeting is available at <http://www.fsis.usda.gov/OPPDE/rdad/FRPubs/2011-0014.pdf>.

The AMI Foundation Review Paper, “Understanding Sodium Replacements from a Food Safety and Health Risk Perspective,” is available at <http://amif.org/ht/a/GetDocumentAction/i/67835>.

► SCIENCE SOUNDBITES

Review Outlines Thermal Pasteurization Requirements for Inactivation of *Salmonella*

A recent review by University of Auckland and Leatherhead Food International examines food-related *Salmonella* outbreaks, the challenge posed by the pathogen and the benefits of pasteurization in *Salmonella* inactivation.

The review summarizes thermal resistance studies of *Salmonella* in poultry and other animal-based foods. Based upon *Salmonella* thermal resistance data, minimum pasteurization times are suggested at different heating temperatures, to meet the guidelines and recommendations of governmental food agencies for meat products.

Salmonella pasteurization requirements of low moisture foods, such as some nuts, chocolate and peanut butter, are also reviewed.

The conclusions and recommendations for thermal pasteurizations can be extended to non-thermal pasteurization processes, it being necessary to determine microbial D- and z-values, or non-thermal resistance parameters of other models, with respect to the new technologies.

Food Research International. DOI: 10.1016/j.foodres.2011.06.018

Sampling Plans Using Indicator Organisms Enhance Process Control, Review Finds

Measuring commonly occurring, non-pathogenic organisms on products may be used for designing statistical process control systems that could result in pathogen reduction, according to a review by the United States Department of Agriculture (USDA).

The extent of pathogen reduction that could be from monitoring these measurements over time depends upon the degree of understanding cause-effect relationships between processing variables, selected output variables and pathogens, researchers determined.

According to the review, if such measurements are to control or improve processing to some capability level within the statistical process control context, sufficiently frequent measurements would be needed to help identify processing deficiencies.

The researchers recommended strategies

that emphasize flexibility, depending upon sampling objectives. Coupling the measurement of levels of indicator organisms with practical emerging technologies and suitable on-site platforms that decrease the time between sample collections and interpreting results would enhance monitoring process control, researchers concluded.

Journal of Food Protection. 2011. 74:1387-1394

Study Evaluates Survival of *E. coli* O157:H7 in Brines Containing Antimicrobials

An AMIF-funded study by Colorado State University researchers examines the survival of *E. coli* O157:H7 in brines formulated without or with antimicrobials.

The brines were formulated in sterile distilled water (simulating the composition of freshly prepared brines) or in a non-sterile 3 percent meat homogenate (simulating the composition of recirculating brines) at concentrations used to moisture-enhance meat to 110 percent of initial weight, as follows: sodium chloride (NaCl, 5.5 percent) + sodium tripolyphosphate (STP, 2.75 percent), NaCl + sodium pyrophosphate (2.75 percent), or NaCl + STP combined with potassium lactate (PL, 22 percent), sodium diacetate (SD, 1.65 percent), PL + SD, lactic acid (3.3 percent), acetic acid (3.3 percent), citric acid (3.3 percent), nisin (0.0165 percent) + ethylenediamine tetraacetic acid (EDTA, 200 mM), pediocin (11000 AU/mL) + EDTA, sodium metasilicate (2.2%), cetylpyridinium chloride (CPC, 5.5 percent), or hops beta acids (0.0055 percent). The brines were inoculated (3 to 4 log CFU/mL) with rifampicin-resistant *E. coli* O157:H7 (8-strain composite) and stored at 4 or 15 °C (24 to 48 h).

Immediate (0 h) pathogen reductions ($P < 0.05$) of 1.8 to ≥ 2.4 log CFU/mL were observed in brines containing CPC or sodium metasilicate. Furthermore, brines formulated with lactic acid, acetic acid, citric acid, nisin + EDTA, pediocin + EDTA, CPC, sodium metasilicate, or hops beta acids had reductions ($P < 0.05$) in pathogen levels during storage; however, the extent of pathogen reduction (0.4 to > 2.4 log CFU/mL) depended on the antimicrobial, brine type, and storage temperature and time.

These data should be useful in development or improvement of brine formulations for control of *E. coli* O157:H7 in moisture-enhanced meat products.

Journal of Food Science. DOI: 10.1111/j.1750-3841.2011

Study: Curing Brines Sourced from Natural Ingredients May Need Additional Antimicrobials

Curing brines containing vegetable juice powder may require additional antimicrobial measures to assure food safety due to the potential for foodborne bacteria, according to research by Iowa State University.

Two ham treatments (one with vegetable juice powder (VJP) and starter culture; one with pre-converted VJP) and a nitrite-added control were examined. No differences (PN0.05) were found for color in the VJP treatments. Control sliced ham was redder after 42 days of storage, retaining significantly ($P < 0.05$) greater redness than either of the VJP treatments. Residual nitrite concentration was greater ($P < 0.05$) in the control hams during the first week of storage. While the nitrite-added control retained greater red color and initially had more residual nitrite than the VJP treatments, the two VJP treatments did not differ from each other.

However, the calculated maximum concentrations of ingoing sodium nitrite of 39 and 60 mg/kg for the two VJP treatments would result in considerably less nitrite formation than added to conventionally cured hams, and less than the USDA-FSIS maximum allowable limit of 200 ppm.

Consequently, the low ingoing concentration of nitrite in the “no nitrate- or nitrite added”, naturally cured products such as those used in this study could be a cause for concern regarding safety; a concern that has been supported by observations of greater growth potential by bacterial pathogens including *Clostridium perfringens* (Jackson et al., 2011) and *Listeria monocytogenes* (Schrader, 2010). Further, the relatively low pH in the incubated brine with *S. carnosus* starter culture could result in relatively rapid dissipation of nitrite from the brine prior to use, and injected nitrite concentrations could be reduced even more.

Meat Science. 2011. 89: 507-513

New Paper Offers Approach to Balance Toxicological, Epidemiological Evidence

Toxicological and epidemiological evidence should be balanced and evaluated to verify conclusions using a systematic approach, according to the authors of a new paper published in *Toxicological Sciences*.

In “Toxicology and Epidemiology: Improving the Science with a Framework for Combining Toxicological and Epidemiological Evidence to Establish Causal Inference,” Has-Olov Adami of the Harvard School of Public Health and colleagues wrote that “The coupled role of epidemiology and toxicology in discerning human health effects by environmental agents is obvious, but there is currently no systematic and transparent way to bring data and analysis of the two disciplines together in a way that provides a unified view on an adverse causal relationship between an agent and a disease.”

In response, they propose a five-step “Epi-Tox” process: **Collection of all relevant studies** – “This may be too obvious, but a serious source of bias is the selective collection of studies,” the authors wrote. They also expressed concerns about non-publication of negative studies that find no effect. “No-effect studies are an important part of the total available data set and their absence biases the overall judgment in favor of studies showing effects,” they said.

Assessment of their quality – Once all studies are collected, each study should be included or excluded using a transparent rationale that is based upon generally accepted criteria for assessing study quality.

Evaluation of weight of evidence – Evaluating the weight of

the epidemiological evidence includes, but is not limited to, effect within and among the studies that is found with strength, consistency, specificity and coherence. In evaluating the toxicological evidence, the question should be asked, “Is the effect of interest present?” If it is, then a mode of action (MOA) analysis should be done to determine applicability to humans. MOA analysis asks three questions: Is there sufficient evidence in animal studies to establish MOA? If so, is that mode of action operative in humans? And if so, considering pharmacokinetic and dynamic characteristics, would the MOA be operative in humans.

Assignment of a scalable conclusion – According to the paper, there needs to be a semi-quantitative conclusion that states the degree to which the studies indicate a positive, a negative or no relationship. “Starting at one end of a scale is not appropriate. Such a starting point implies that as studies are accumulated, a positive association will be identified when the reverse, a lack of association may also become increasingly plausible as scientific evidence accumulates,” they wrote. Scaling should start at the center of the scale and move in positive or negative directions

Placement on a causal relationship grid – The authors propose a visual grid to evaluate the combined weight of toxicological and epidemiological evidence.

“A framework can provide the logic and disciplined thinking that promotes open discourse and leads to evidence-based decisions,” the authors concluded. “Important decision about human safety should rely on the cohesive appreciation of both epidemiology and toxicology... .”

► AMIF EDUCATION

Meat and Poultry Research Conference to be Held Nov. 1-2

The most important industry topics today will take center stage at this year’s inaugural Meat and Poultry Research Conference, to be held November 1-2, 2011, in Kansas City, Missouri. Topics to be addressed include the use of antibiotics in livestock production, meat and poultry product quality, health and nutrition and food safety.

To view the full agenda, go to <http://www.meatami.com/ht/d/sp/i/69917/pid/69917>.

To register, go to <http://www.meatami.com/ht/d/sp/i/69917/pid/69917> or contact AMI Manager of Convention and Exposition Services Rosie Levine at rlevine@meatami.com.

AMIF Offers Workshops on *Listeria monocytogenes* and Allergen Control

The AMI Foundation is offering two back-to-back educational workshops this December that will address two of the most relevant issues in the meat and poultry industry today: *Listeria monocytogenes* and

allergen control.

The AMI Foundation Advanced *Listeria monocytogenes* Intervention and Control Workshop, co-sponsored by the North American Meat Processors Association (NAMP) and the Canadian Meat Council (CMC), will be held December 6-7, 2011, at the Hilton Rosemont in Chicago, Illinois.

This updated educational opportunity is designed to help manufacturers of ready-to-eat (RTE) meat and meat products examine the issues surrounding control methods, and to provide experience in developing appropriate sanitation protocols and testing plans for processing RTE products.

The Allergen Control for the Meat and Poultry Industry Workshop will be held December 7-8, also at the Hilton Rosemont in Chicago. This workshop is being cosponsored by the Food Allergy Research and Resource Program (FARRP) at University of Nebraska-Lincoln.

ghAdverse physical reactions to food are of growing concern to both consumers and to food product manufacturers. Liability and recall issues, as well as recent changes to labeling laws, have had an impact on the way meat and poultry manufactures develop and

process their products

Space for each workshop is limited to 60 participants. For more information and to register, go to <http://meatami.com/ht/d/sp/i/40701/pid/40701>.

Industry Professionals Attend Animal Care and Handling Conference

Nearly 300 industry professionals attended The AMI Foundation (AMIF) Animal Care and Handling Conference for the Food Industry, held October 19-20, 2011, at the Westin Crown Center, Kansas City.

Sessions addressed a wide range of topics including: sustainability, myth crushing, best practices; the relationship between good handling and quality; effects of trailer microclimate and density on carcass quality; impact of stress during transport (dairy cows); veal production; impacts of animal well-being and welfare on media and meat demand; responding to NRs; crisis management and more.

▶ AMIF ONGOING RESEARCH

Shiga Toxin-Producing E. coli

<u>Investigator</u>	<u>Institution</u>	<u>Project Title</u>
Rodney Moxley	University of Nebraska	Effect of flagellin and intimin type expression on colonization of bovine intestine by non-O157 serotypes Shiga toxin-producing <i>E. coli</i> (Phase 2 only)
Fred Pohlman, Steven Ricke, Palika Dias-Morse, Anand Mohan, Sara Milillo, Peggy Cook, Karen Beers	University of Arkansas, Safe Foods International	Antimicrobial interventions/application methods for the reduction of <i>Escherichia coli</i> O157:H7 and <i>Salmonella</i> in beef trimming and/or ground beef

Listeria monocytogenes

<u>Investigator</u>	<u>Institution</u>	<u>Project Title</u>
Haley Oliver, Martin Wiedmann	Purdue University, Cornell University	Development and Evaluation of Control Strategies for <i>Listeria monocytogenes</i> in Retail Deli Environments ¹
Joseph Sebranek, James Dickson, Byron Brehm-Stecher, Stephanie Jung, Aubrey Mendonca	Iowa State University	Reducing or Preventing Recovery of Injured <i>Listeria monocytogenes</i> on Ready-to-Eat Natural and Organic “Uncured” Processed Meats
Richard Meinersmann, Mark Berrang, Tim Hollibaugh, Joseph Frank	Agricultural Research Service, USDA, University of Georgia	Role of Protozoa in the Persistence of <i>Listeria monocytogenes</i> in a Ready-to-Eat Poultry Processing Plant

¹Co-sponsored by Food Marketing Institute

Salmonella

<u>Investigator</u>	<u>Institution</u>	<u>Project Title</u>
Jeffrey Sindelar, Kathleen Glass, Robert Hanson	University of Wisconsin, HansonTech	Developing Validated Time-Temperature Thermal Processing Guidelines for Ready-To-Eat Deli Meat and Poultry Products

Diet and Health

<u>Investigator</u>	<u>Institution</u>	<u>Project Title</u>
Andrew Milkowski, Jim Coughlin, Nathan Bryan, Dominik Alexander	Milkowski Consulting LLC, Coughlin & Associates, University of Texas Medical School – Houston, Exponent	Response to International Agency for Research on Cancer 2A Classification of Nitrite (and Nitrate)

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