

2011 BEEF SAFETY SUMMIT EXECUTIVE SUMMARY

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Introduction

For the past nine years, the Beef Industry Safety Summit has been the hallmark of the U.S. cattle industry's commitment to providing the most wholesome product possible. "The number of people attending this meeting says so much about the commitment to beef safety from everyone throughout the chain," said Dr. Bo Reagan, senior vice president of research, education and innovation for the National Cattlemen's Beef Association (NCBA). First held in 2003, the Beef Industry Safety Summit has become the premier meeting to discuss current and emerging beef safety challenges. This year's summit set another record for attendance levels.

The Beef Industry Safety Summit is coordinated by NCBA on behalf of the Beef industry Food Safety Council (BIFSCo) and is partially funded by The Beef Checkoff. Beef producers, through the beef checkoff, have invested more than 30 million dollars in beef safety since 1993.

Every Beef Industry Safety Summit has included frank discussions about emerging issues. This year that was especially true as researchers collaborated with industry participants to identify some of the newest challenges to beef safety.

"Consumers are safer because of what you do," said Dr. Elisabeth Hagen, U.S. Department of Agriculture (USDA) under secretary for food safety during her keynote address. "When the industry needed a plan to address food safety, it was you who came together to accomplish that goal as you realized that a fragmented approach wasn't working. Thank you for everything you've done and everything you will do in the future."



Dr. Elisabeth Hagen, U.S. Department of Agriculture (USDA)

Technical Sessions

The format of the Beef Industry Safety Summit changes every year to best address some of the most pressing challenges. This year, a large portion of the program agenda was focused on research and technical sessions. Attendees were encouraged to engage the speakers in discussion to identify optimal solutions and the next steps to continue to improve beef safety.

Issue: Non-O157 STEC

E. coli O157:H7 was first recognized as a disease-causing organism in 1982. While significant progress has been made in reducing the number of people impacted by this pathogen, research has also revealed non-O157 Shiga toxin-producing *E. coli* (STEC) have the potential to impact public health. In her opening remarks, Dr. Elisabeth Hagen said, “*E. coli* O157 caught us unprepared in 1993. While we have certainly made progress on O157, we have also learned a lot about other pathogens of concern, including non-O157 STEC. Public health should be our priority, and as a result, we need to continue to address STEC.”

Discussion

Dr. Rajal Mody, medical epidemiologist with the Centers for Disease Control and Prevention (CDC) provided a basic background of non-O157 STEC and their potential as a newly emerging threat to food safety. “STEC include *E. coli* that produce one or more Shiga toxins. *E. coli* O157:H7 is the most virulent and the one we are most familiar with as it causes one-third of human STEC illnesses and is responsible for 90 percent or more of severe infections,” said Mody. “There are many other STEC (commonly referred to as non-O157 STEC) and the severity of illness they cause depends on the virulence factors they possess.”

While non-O157 STEC are not as virulent as *E. coli* O157:H7, their impact on human health is difficult to gauge from current epidemiological evaluations. In 2007, only 4 percent of clinical laboratories tested human stool samples routinely for Shiga toxin, which is the only way to find non-O157 STEC that could impact human health.

To gain a better understanding of their impact, the CDC has recommended clinical labs should routinely screen all stool samples from patients with community-acquired diarrhea for both non-O157 and O157. They should also work with public health labs so all STEC are identified by O group.

Incidence of lab-confirmed cases of non-O157 STEC has increased due to additional testing, according to Mody. Six serogroups comprise approximately three-quarters of the human isolates detected. Food is a major mode of transmission for *E. coli* O157, but for non-O157 STEC, a variety of transmission routes and a variety of food vehicles have emerged.

Dr. Terry Arthur, a researcher with the USDA Agricultural Research Service (ARS) U.S. Meat Animal Research Center discussed the application of existing knowledge about *E. coli* O157:H7 in understanding non-O157 STEC. “Our discussion about non-O157 STEC has to be based on science,” said Arthur.

“The beef industry has focused on *E. coli* O157:H7 extensively, but now we have also identified the need to better understand non-O157 STEC. Based on genetic profiling, it appears differences exist in origins among the various serotypes of non-O157 STEC and *E. coli* O157:H7, but they also appear to exhibit similar relationships.”

Arthur said that analyzing genome expression is only part of the picture in understanding non-O157 STEC. “Gene expression and regulation play an equally important role, but it is more difficult to characterize phenotype than genotype,” said Arthur. “The difference can be equated to reading musical notes versus what the actual music sounds like.”

Arthur compared various characteristics of non-O157 STEC to *E. coli* O157:H7, including colonization, shedding, persistence, acid tolerance, as well as survival rates. Arthur presented a review of previous research that showed interventions designed for *E. coli* O157:H7 were effective at reducing *E. coli* O11:H8 and *E. coli* O26:H11, but more research is needed to determine the best ways to address all non-O157 STEC.

Next Steps

To better understand the impact of non-O157 STEC on human health, routine testing by clinical laboratories needs to include identifying all STEC by O group. More work needs to be done to understand the genetic expression of non-O157 STEC and how they compare to existing knowledge about *E. coli* O157:H7.

Several knowledge gaps and research needs were identified regarding non-O157 STEC, including:

- What are the selective pressures and mechanisms driving the parallel evolution of all enterohemorrhagic *E. coli* (EHEC)?
- What are the determinants of STEC risk? Profiling genome sequences across the STEC continuum will help answer this question.
- Do non-O157 STEC colonize the recto anal junction (RAJ) in cattle similar to *E. coli* O157:H7? Understanding this will aid in developing pre-harvest interventions as effective on non-O157 STEC as current interventions are on O157.
- Do non-O157 STEC attain super shedding levels in cattle as has been identified with *E. coli* O157:H7?
- How do non-O157 STEC respond to current and emerging pre-harvest interventions?

Estimates of Annual STEC Infections

	STEC O157	Non-O157 STEC	Total
All illnesses	96,000	169,000	265,000
Foodborne illnesses	63,000	113,000	176,000
Hospitalizations	3,300	400	3,700
Deaths	30	0	30

Issue: Non-intact Beef Products

Various methods to enhance beef quality, including needle or blade tenderization and liquid injection, have the potential to translocate bacteria from the surface to the interior of beef products. Researchers presented study results to help define the risks associated with non-intact products and methods to minimize those risks.

Discussion

In 2003, the first product recall associated with non-intact beef occurred. Since that time, additional research has been completed to better understand how tenderization and enhancement procedures may impact beef safety.

Dr. John Sofos, a researcher with Colorado State University, presented data covering results from several studies. To better understand potential risks for pathogen contamination of non-intact beef products, studying the transfer and internalization of bacterial cells is necessary. Additionally, Sofos' research outlined the impact of enhancement and the ingredients in brine solution on bacterial contamination. The research also analyzed how various cooking scenarios affected non-intact product performance and bacterial inactivation.

Sofos' research found *E. coli* O157:H7 can be transferred to the interior of non-intact products through needle injection when either the surface of the meat or the brine was contaminated. Blade tenderization was also shown to transfer contamination from the surface to the interior of meat products. Certain additions to brine solutions, most notably, lactic, acetic, and citric acid, as well as sodium metasilicate and cetylpyridinium chloride (CPC) did reduce contamination rates. CPC also enhanced thermal inactivation of bacteria.

Cooking method appeared to have an effect on the survival rate of pathogens in non-intact products. When pan-broiling, pathogen survival increased with depth of contamination, but when non-intact product was roasted, no differences in pathogen survival at different depths of contamination were evident.

"Proper cooking equals safe products," said Sofos. "For non-intact products, it appears that achieving a proper internal temperature can be complicated by several variables."

Dr. John Luchansky, a researcher with USDA-ARS, presented additional research about the translocation and thermal inactivation of *E. coli* O157:H7 and non-O157 STEC in non-intact beef.

Luchansky's work shows no discernible differences among the levels of translocation for *E. coli* O157:H7 and non-O157 STEC following blade tenderization or chemical injection of beef subprimals. The majority of the pathogen translocation occurred at a depth of approximately one centimeter. "More transfer of bacteria occurs with a single pass of needles through the lean side versus using a double pass on the fat side of the experimental products," said Luchansky.

His results also showed no discernible differences exist in thermal resistance between non-O157 STEC and *E. coli* O157:H7 following cooking of blade-tenderized or injected steaks.



"Higher cooking temperatures generated greater lethality, but no difference in lethality was seen based on steak thickness (1.0 or 1.5 inches). Subtle differences in thermal resistance existed in steaks cooked to 140°F and injected with brine with or without lactate. Luchansky's work shows that non-O157 STEC behave similarly to *E. coli* O157:H7 in non-intact beef products.

Next Steps

The work of both researchers demonstrates a need for the development of brining, marination, tenderization and restructuring procedures to better control *E. coli* O157:H7 in non-intact meat products. Differences in enhanced product attributes must also be accounted for when developing proper cooking recommendations for consumers. All of this work will aid in updating risk assessments for non-intact beef products.

Factors that influence thermal resistance of *E. coli* O157:H7 and non-O157 STEC should be further researched. Sanitation procedures for tenderizing and enhancement equipment should be evaluated and validated. Antimicrobial treatments for use on subprimals and trim prior to enhancement should be explored further to minimize the risk of translocation of pathogens from the exterior surface.

Issue: Sampling/Lotting and Event Programs

In an introductory session that focused on learnings from recent recalls, Dr. Barb Masters, senior policy advisor at Olsson, Frank and Weeda Law and former administrator for the USDA Food Safety and Inspection Service (FSIS), reviewed learnings from *E. coli* O157:H7 recalls that occurred in 2009 and 2010. "The idea of mandatory 'test and control' has been considered by FSIS since 2004. During the period between 2009 and 2010, the industry experienced five recalls because establishments did not hold any product and at least six more recalls occurred because the lots were not properly defined." Masters pointed to the BIFSCo "Best Practices for Sampling and Lotting of Beef Products and Sample Analysis for Pathogens" released during this year's summit as one tool that could assist in preventing recalls associated with inadequate lotting or sampling procedures.

Discussion

"You can't determine a lot size if it doesn't fit your lot profile," said Brenden McCullough, vice president of technical services for National Beef Packing Co. LLC. "The expectation is that you have to be able to support how you define a 'lot.' It must have defined separation, and you have to ask yourself if the lot is truly microbially independent, and can you control the raw materials that contribute to that lot?"

McCullough explained that the presentations and recommendations from BIFSCo were not designed to be "set in stone" or applicable in all situations, but rather suggestions on issues to understand and address as each individual facility determines the best way to lot product within their own systems. "Ultimately, you have to be able to support your decisions," said McCullough.

When a harvest or processing facility identifies higher-than-normal positive microbiological testing results, that occurrence is often referred to as an "event day" or "event window."

"Adequate documentation and traceability is critical to establish a system to chronologically sequence your production and sampling," said Chad Martin, senior director of food safety and quality assurance with Tyson Foods. "The take-home message from this discussion should be that companies need to have plans to address 'event days.' It's our responsibility to determine the severity of the issue and control affected products quickly. It's also our job to critically investigate the process and apply a 'reaction' mindset before an event day ever occurs."

Dr. John Ruby, director of technical services for JBS USA, related his own experiences in handling event days and said: "Event days are real things that will happen if you are not prepared. It is important to have a program you can follow in the heat of the moment." Ruby's advice included using process indicators as triggers for action plans. "Identify the good parts of your system and focus your resources on the bad."

Next Steps

All of the speakers for this session emphasized the importance of having good plans to address event days. It's important to be able to determine the severity of an issue and control any affected products quickly. To accomplish that, individual companies must critically investigate their own processes and apply their "reaction mindset" before an "event window" ever occurs.





Issue: Validation

The best beef safety program is ineffectual unless beef harvest establishments and beef processors can validate the system is working. Validation is focused on collecting and evaluating scientific and technical information to determine whether the Hazard Analysis Critical Control Point (HACCP) plan, when properly implemented, will effectively control food safety hazards. In other words, validation helps companies determine if their HACCP systems are functioning as intended.

Discussion

Dr. Scott Goltry, vice president of food safety and inspection services for the American Meat Institute, discussed the role of validation in HACCP programs and topics in-plant personnel should consider when conducting self-assessments. Harvest facilities use supporting documents to establish procedures for validation programs. Goltry said it is important that plants have processes in place that are effectively, but not necessarily exactly, the same as the supporting document.

“If specific parameters are met, supplying effectiveness data need not be required,” he said. “If parameters are not met, or if the supporting document does not apply to the process, then information is needed to validate process effectiveness.”

Dr. Gary Acuff, director of the Center for Food Safety at Texas A&M University, continued the discussion about validation. “Pathogen presence on carcass surfaces is inconsistent, occurs at low levels and can be insufficient for the confirmation that a process control or intervention is effective,” said Acuff. “Are there measurable alternatives in the form of indicator organisms?”

“An ideal indicator is going to have the same heat and acid resistance as the pathogen of interest; will have similar growth characteristics; is not pathogenic; and should be easy to detect

and enumerate.” As part of the discussion, Acuff outlined research related to the use of “surrogate” cells as indicator organisms.

“As we address beef safety, we have to ask, ‘what is realistic?’” said Acuff. “Is it complete elimination of the pathogen, which is essentially impossible, or is it a reduction? When *E. coli* O157:H7 was declared an adulterant, the goal was well-intended, but short-sighted, because it requires us to attain a ‘zero presence,’ when that doesn’t exist.

“Validation helps us meet the regulatory requirement,” added Acuff, “but it also allows us to measure progress toward an endpoint. Standardization in validation has some advantages, but I think the disadvantages are more, as it is difficult to standardize when industry applies so many different interventions. Facilities’ validation processes should adjust to the product, process and facility.”

Dr. Kerri Harris, president and CEO of the International HACCP Alliance, presented background on two studies using surrogates to validate the effectiveness of interventions in a plant setting. The research helps determine when plants should inoculate with surrogates and how the concept can best be applied in industry. “Part of our work helps us better understand the critical parameters and their appropriate use.”

Next Steps

Further research should address the optimal time to inoculate beef carcasses during validation programs. Additionally, methods for achieving consistent levels of inoculums should be further studied. Finally, it was stressed that validation programs in plants should not be striving to achieve the same results obtained in the supporting document; but, rather apply knowledge with the understanding that the parameters were developed in a lab setting and not in a plant setting.

Issue: Beef Safety Interventions

The beef industry has devoted millions of dollars to developing and validating post-harvest safety interventions. In more recent years, those efforts have also included exploring pre-harvest interventions and their role in reducing the pathogen load on cattle presented for harvest.

Discussion

“The intervention focus is expanding,” said Dr. Angie Siemens, vice president of technical solutions for Cargill Meat Solutions. “A lot of interventions we apply throughout the harvest process have also spread to the fabrication floor and to ground beef production. Based on potential regulatory requirements, we will probably continue to expand into more pre-harvest interventions and more hide-on carcass treatments as a means to prevent contamination during hide removal.” Cargill and JBS USA have recently added video monitoring to their food safety arsenal with an eye toward improving employee practices.

Siemens reviewed several post-harvest intervention technologies and discussed how these technologies may be modified to address new challenges. “This is a process of continuous innovation and improvement as we continue to explore new technologies and systems within our own operations and plants and as an industry as a whole.”

“We have seen tremendous progress in addressing food safety in the beef industry,” said Dr. Guy Loneragan, a researcher with Texas Tech University. “We reached the Healthy People 2010 goal established by the government two years ahead of schedule, but we occasionally still see a loss of process control in harvest facilities where we are potentially overwhelming the system or we see a system failure. Most of these incidents, but not all, are detected prior to the product being distributed for consumption. The question we have been exploring, is ‘What can we do at pre-harvest so the in-plant interventions remain effective?’”

Loneragan discussed results from two studies that explored the application of an *E. coli* O157:H7 vaccine in a feedlot setting. “The siderophore-based vaccine, which interferes with bacteria’s iron uptake, was associated with a reduced burden of *E. coli* O157, but this was not the consistent result seen in all studies in the literature.

“When evaluating pre-harvest interventions, cost is going to be a factor as no direct benefit returns to cattle producers” he said. “Not all behaviors or practices are driven purely by economic factors.” A recently published quantitative risk assessment and marginal cost analysis of the vaccine built on the assumption that human illnesses are a function of the prevalence of *E. coli* O157:H7 in cattle. The study concluded the potential public health savings are greater than the cost of the vaccine.

“A large percentage of consumers don’t cook our product correctly, and that’s why we must have safety interventions,” said Dr. Pat Mies, technical consultant for Elanco Food Solutions. Mies discussed the current status of pre-harvest interventions developed by Elanco, including Finalyse®, a phage-based hide-wash technology that is used to aid in the reduction of *E. coli* O157:H7 on cattle presented for harvest.

Phage are naturally occurring, and are very specific to certain bacterial hosts; therefore they can be used safely in a variety of agricultural and food safety applications. “Not all bugs are bad, and phage are some of those that can prove beneficial in addressing food safety challenges,” said Mies.

Mies also discussed sodium chlorate as a pre-harvest intervention. Used as a feed additive in the period prior to harvest, sodium chlorate has been shown effective in reducing *E. coli* O157:H7 and Salmonella by reducing bacterial populations in the gastrointestinal tract. However, the product is still pending approval for commercial use by the Food and Drug Administration (FDA).

Dr. Tom Besser, a researcher with Washington State University discussed research projects focusing on pre-harvest interventions to address *E. coli* O157:H7 and multi-drug resistant Salmonella. “When the first major outbreak of *E. coli* O157:H7 occurred in the early 1990s, a physician treating one of the children said he believed controlling the pathogen at the animal level was one of the best ways to address the issue. He said that once the children were at the hospital, too few therapies were available to treat them effectively,” said Besser. “Nearly 20 years later, we’ve made some progress in pre-harvest safety interventions, but not enough.”

Besser’s research has focused on several strategies including a high efficacy mucosal vaccine for *E. coli* O157:H7, causes for seasonal variation in EHEC shedding by cattle, the role of super shedders in pathogen prevalence, and virulence factors in different *E. coli* O157:H7 genotypes. His work has also focused on the use of antibiotics at the farm level and its impact on the development of drug-resistant bacteria.

“Ceftiofur is one of the most commonly used drugs for several cattle diseases. Our question was whether its use increases the risk of ceftiofur resistant *E. coli* and Salmonella infection,” said Besser. “Our research found that there was no correlation between ceftiofur use and ceftiofur-resistant *E. coli*.”

A separate study analyzed ceftiofur use on-farm and the presence of ceftiofur-resistant Salmonella and found herds that harbored the resistant bacteria (15 out of 39), were not receiving more of the antibiotic than the non-infected herds.

Next Steps

Siemens referenced the BIFSCO “Best Practices for Beef Slaughter” released in 2009 and suggested it may be time to update the guidelines to reflect new knowledge and research. More research and validation work needs to be done on the various pre-harvest interventions currently being explored. In addition, streamlining the regulatory process for product approval for commercial use is needed.

The mechanisms by which multi-drug resistant bacteria evolve and disseminate also deserve more research. Focusing on targeted therapies for animal health issues appears to be one potential solution to reducing clinical illness in animals, while still accomplishing the goal of reducing the development of multi drug-resistant bacteria, but more work needs to be done.

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Beef Safety and Production Web Resources

www.BIFSCo.org

www.SafeandSavory160.com

www.BeefRetail.org

www.BeefFoodService.com

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