

Meat Safety News Digests

A collection of recent news relevant to the safety of red meat prepared by the Food Safety Program of Meat & Livestock Australia, for SAFEMEAT Stakeholders

INTERVENTIONS

A model to evaluate interventions on *E. coli* public health risk

A group of Canadian researchers developed a quantitative risk assessment model to evaluate the relative effects of pre-harvest and processing interventions on public health risks associated with consumption of beef products contaminated with *E. coli* O157:H7. This model used data from a critical systematic review and relevant published literature, rather than considering efficacy of all interventions at primary production and processing as default values. The model then estimated the efficacies of different intervention strategies to reduce public health risks (i.e., probability of illness per serving) from consumption of ground beef, non-intact beef cuts, and intact beef cuts contaminated with *E. coli* O157:H7, relative to a worst-case scenario where no pre-harvest or processing interventions were applied. Most interventions applied alone at pre-harvest or during processing reduced risks by 30.9% to 96.5%. Only application of water spray-chilling appeared to increase the average probability of illness per serving by up to 11.3%. However, combinations of pre-harvest and processing interventions resulted in the greatest relative risk reductions of up to 99.9%. By using the

data available for the efficacy of current practices in Canada, the model indicated that risks from consumption of ground beef were approximately 2-3 orders of magnitude greater than those for beef cuts. This suggests control measures should focus on ground beef to minimise the risk. It was also found that the process of tenderization increased risks from consumption of beef cuts. The model developed can provide a useful tool for risk managers to determine and compare relative efficacies of different intervention strategies to reduce public health risks.

<http://www.sciencedirect.com/science/article/pii/S0956713512001223>

Survival of *E. coli* during carcass heat treatments

This Canadian study investigated whether reduction in numbers of total *E. coli* found on beef could be used as indicative of the reduction in numbers of STEC and STEC O157 resulting from the same heat treatment. Swab samples collected from hide-on beef carcasses were enriched for *E. coli* in rich medium supplemented with the antibiotic novobiocin. The enriched samples were then treated with or without heat at 55, 60, 65 and 70°C, before they were subjected to molecular analysis (i.e., real-time PCR) for determining the numbers of total *E. coli*, STEC and STEC O157. It was found that the maximum difference in reduction of numbers total *E.*

coli, STEC and STEC O157 as a result of heating was ≤ 0.3 log units. This difference was less than the 0.5 log units that is generally considered to be microbiologically significant. Therefore, the findings indicate that the effects of heat-treatments on total *E. coli* populations on beef carcasses can be regarded as indicative for the effects of the treatments on total STEC and STEC O157 on carcasses.

<http://www.sciencedirect.com/science/article/pii/S0956713513005781>

Effects of high-pressure processing and boiling water treatments on pathogens during beef jerky processing

The objective of this USA study was to evaluate the efficacy of high-pressure processing (HPP) and boiling water treatments on reducing *Listeria monocytogenes*, *Escherichia coli* O157:H7, *Salmonella* spp., and *Staphylococcus aureus* during beef jerky processing. HPP treatment (550 MPa for 60 sec) was applied to vacuum-packaged dehydrated jerky, whereas marinated raw beef strips were treated with boiling water (100°C for 20-30 sec) prior to dehydration. HPP reduced *Salmonella* and *E. coli* O157:H7 by at least 4 log units on the finished products. However, this treatment only caused a slight reduction in numbers (approximately 1 log unit) of *L. monocytogenes* and *S. aureus* on the products. Boiling water treatment reduced all pathogens greater than 5 log units on the resulting beef jerky. These results indicated that boiling water treatment could be used as an effective intervention in reducing pathogens during beef jerky processing, although future validation of this treatment in-plant is still required.

<http://www.sciencedirect.com/science/article/pii/S0956713513005756>

Methods of knife disinfection

Knives are used at various steps of the meat processing operation. Their contamination with pathogenic and spoilage microorganisms can occur during slaughter, preparation of carcasses and different cuts. Sanitisation of knives must be considered a component of overall hygienic control. At present, EU Regulation 853/2004 requires that knives used in meat processing be disinfected by submerging in hot water (82°C). Alternative procedures are permitted, if the efficacy is proved to be equivalent.

In the present study, German researchers investigated various time-temperature combinations together with pure hot water, water + 2% lactic acid and ultrasound rays with and without 2% lactic acid. Disinfection efficacy of these procedures was evaluated using wet-dry-swab technique that ensured maximum bacterial recovery. Results showed that sanitisation of knives was attainable in 10s either by using hot water (70°C) alone or combination of hot water bath (40°C) and lactic acid. Further reduction in time (5s) was realistic if ultrasound was used along with hot water (60°C) or combined with lactic acid (2%) and hot water (40°C). In particular, use of lactic acid showed an appreciable reduction of the temperature while providing effective sterilization.

<http://www.sciencedirect.com/science/article/pii/S0309174013001575>

MODIFIED ATMOSPHERE PACKAGING

A method for *E. coli* O157:H7 and *Salmonella* spp. control in fresh beef using poly-lysine and modified atmosphere packaging

This study investigated the antimicrobial effectiveness of poly-lysine (L-lysine polypeptide) alone and in combination with 100% CO₂-packaging against *E. coli* O157 and *Salmonella* in raw beef at 4 and 10°C. Results showed that at 4°C poly-lysine alone caused 4.3 and 2.4 log reduction in *E. coli* O157 and *Salmonella*, respectively, after seven day of storage. Use of anaerobic packaging (100% CO₂) alongside poly-lysine did not prove beneficial at 4°C. However, an additional benefit of CO₂ was observed when meat was stored at 10°C. Specifically, there was approximately 1.5 times greater reduction in *E. coli* O157 (2.9 log versus 4.4 log with poly-lysine alone and poly-lysine + CO₂, respectively) and for *Salmonella* (1.7 log versus 3.5 log with poly-lysine alone and poly-lysine + CO₂, respectively). Being a first study to investigate the combined use of poly-lysine and modified atmosphere packaging as an antimicrobial technique, the present study provides new knowledge into preventing growth of pathogenic bacteria in fresh beef.

<http://www.sciencedirect.com/science/article/pii/S095671351300474X>

SAMPLING PROCEDURES

Impact of sampling area on measurement of indicator organisms

The objective of this USA study was to evaluate the effectiveness of the sponge sampling method on the

recovery of multiple indicator organisms from beef carcass surfaces. A total of 248 sponge samples were collected at three beef processing plants that used hot water or acidic antimicrobials as interventions. Surface samples were collected from two areas on pre-eviscerated carcasses before and after exposure to a wash cabinet intervention. The sample areas were the inside and outside round area (top site), and the navel-plate-brisket-foreshank area (bottom site). All samples were tested for numbers of total aerobic bacteria, coliforms, *Enterobacteriaceae*, and *E. coli*. The results indicated no differences in relative levels of indicator organisms on pre-intervention carcass samples collected from the top and bottom sites. Reductions of indicator organisms were observed for all sponge samples after the intervention had been applied. However, the samples from the bottom site of the carcasses showed greater reductions compared to the top site. These results indicate that samples collected from either the top or bottom site of beef carcasses can be used to monitor background levels of indicator organisms, as long as the same sampling site is consistently tested.

<http://www.ingentaconnect.com/content/iafp/jfp/2013/00000076/00000012/art00012>

PATHOGEN PREVALANCE

***E. coli* O157:H7 strains isolated from raw beef trim during 'high-event periods' of contamination**

In this study, USA researchers characterised *E. coli* O157:H7 isolates from twenty-one "High Event Periods" (HEP) of contamination across multiple companies and processing plants to gain

insight about mechanisms that cause such high incidents. A DNA fingerprinting technique (i.e., pulsed field gel electrophoresis) was used to determine strain genotype. Isolates were also tested for virulence factors associated with human infection. The results revealed that there was little or no diversity of strain genotype in each HEP, indicating that individual HEPs have one strain type that makes-up most of the contamination. These were inconsistent with the high diversity of *E. coli* O157:H7 found on the hides of cattle entering processing plants. In addition, it was found that a high proportion (81%) of HEPs was caused by strains known to cause human illness. The results of the study pose a potential challenge to current practices used to control or reduce contamination of finished beef products during high incidents.

<http://aem.asm.org/content/early/2013/11/04/AEM.03192-13.abstract?etoc>

Occurrence of *E. coli* O103 in Norwegian Sheep

The aim of this Norwegian study was to identify and describe reservoirs of human-pathogenic *E. coli* O103, in particular H types 2 and 25 in sheep flocks. A total of 1,222 *E. coli* O103 isolates were collected from 585 fecal samples nationally. These isolates were analyzed for different pathogenic genes using molecular typing. Results showed high genetic diversity among studied isolates with regard to virulence. Human-pathogenic *E. coli* O103 isolates were geographically widely distributed among sheep flocks without any regional association. Furthermore, occurrence of non-pathogenic *E. coli* O103 was common in sheep (27.5% of studied flocks), while the prevalence of potentially human-pathogenic Shiga

toxin-producing *E. coli* O103:H2 was low (0.7%) and STEC O103:H25 was not detected in sheep fecal samples.

<http://aem.asm.org/content/79/23/7502.abstract?etoc>

MEAT SPOILAGE

Significance of heme-based respiration in microbial meat spoilage

Finnish researchers studied the effect of meat respiration on growth rate, biomass production, gene expression and production of volatile organic compounds by *Leuconostoc gasicomitatu* strains, a meat spoilage lactic acid bacterium, in laboratory media and meat. Results showed that meat respiration increased the growth rate (23 – 46%) of *L. gasicomitatu* on media with added heme and *in situ* pork loin with endogenous heme, which also affected gene expression in the bacteria. Respiration increased (up to 2,600-fold) the accumulation of buttery off-odor compounds in meat. Furthermore, O₂ accelerated meat spoilage at 6°C (in 13 days under high oxygen MAP (20% CO₂ and 80% O₂) as compared to 24 days under 20% CO₂ and 80% N₂). This study demonstrated that heme-based respiration is one key factor explaining why *L. gasicomitatu* is so well adapted in high-oxygen packed meat. Without respiration, O₂ has a negative effect on the growth of this spoilage bacterium, however growth/spoilage was enhanced with respiration.

<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3568588/>

FOOD SAFETY MANAGEMENT

HACCP systems of Mexican and Chinese meat exporters

In this study, researchers assessed and compared the implementation of HACCP systems between Mexican and Chinese meat industries. A total of 32 Chinese and 42 Mexican companies participated in the survey and were asked to answer a set of questions to identify incentives, costs, difficulties and benefits of implementing HACCP systems. The results indicated that the major incentives were quality improvement of products for both countries. However, the greatest incentive for the Chinese industry was in improving process control, whereas access to new foreign markets was the highest incentive for the Mexican industry.

Another major difference between both countries' industries was difficulty in adopting HACCP systems. The major problems encountered by the Chinese industry were retraining production staff, reduced staff time available to perform other tasks, and changes in the attitude and motivation of production staff. In contrast, high costs associated with HACCP certification was the major issue for Mexican companies. Industries in both countries reported that staff-training and product-testing were major costs related to implementing and operating HACCP systems, respectively. These industries also appeared to realise the same benefits of implementing the HACCP systems, which are known to reduce microbial counts and increase access to foreign and domestic markets. The results of the study highlighted similarities and differences in implementation of HACCP systems

between Mexican and Chinese meat industries, and confirm the importance of HACCP systems in domestic and foreign trade.

<http://www.sciencedirect.com/science/article/pii/S0956713513005409>

E. coli testing in beef trim – limits of food safety testing

This paper reviewed the two roles (a plant's food safety plan effectiveness and detecting contaminated product) of *E. coli* O157:H7 food safety risk-testing of beef trim in US. Furthermore, authors evaluated the impact of increased sampling on production cost, incentives to manufacturer and food safety outcomes. Findings showed that increased sampling only affected the cost of implementation of required food safety standards without showing direct consumer health benefits. Processing plants will only adopt increased sampling strategies provided there are significant incentives to do so. On the other hand, increased sampling can reduce testing errors in catching contaminated product, thereby directly affecting consumer food safety.

<http://www.sciencedirect.com/science/article/pii/S0956713513005525>

NOVEL TECHNOLOGIES

Intelligent packaging

Researchers in the Netherlands are working on smart packaging capable of monitoring and predicting freshness of stored food that can be sensed through smart phones. The concept involves monitoring volatiles in headspace of the package (by putting a sensor in the packaging) and combining these data with mathematical modelling to

determine product shelf-life, thereby helping to monitor product quality in the supply chain without opening the packaging. Besides providing greater quality assurance, this technology can quickly identify problems in the supply chain, and thus reduce chances of distributing unsafe/poor quality food. Furthermore, shelf-life data and strategies such as First Expire-First Out can help management with decisions regarding shipment timing and destinations. At present, the technology is being developed for fish with possible extension to other perishable foods such as meat and meat products.

<http://www.foodproductiondaily.com/Innovations/Packaging-tells-smartphone-when-fish-has-gone-off>

Temperature management in the supply chain

The aim of this paper was to evaluate different methods used to define an optimal target temperature for multi-commodity chilled storage transport and feasibility of sensor-based methods for real-time quality monitoring. As a first step, chilled products were classified into clusters of different temperature regimes. Three methods were evaluated to define

the optimal targeted temperature settings for refrigerated storage of food under multi-commodity cold storage management. The results showed that mathematical algorithm-based clustering was successful in dividing chilled products into different manageable temperature zones. For real-time quality status of the product, a Smart Cold Chain Management (SCCM) system was proposed that involved technologies such as sensors, radio frequency identification (RFID) and wireless networking, thus enabling data collection, processing, storage and retrieval from a central database at a Cold Data Centre through the internet. Relationships among deterioration rate, shelf-life and freshness were evaluated and methods formulated to access the quality of perishable foods in real-time. The sensor-based methods for real-time quality monitoring were found to be superior to traditional visual assessment method.

<http://www.sciencedirect.com/science/article/pii/S0956713513005902>

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