

## Meat Safety News Digest

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

### TREATMENT TECHNOLOGY

#### Effect of hydrodynamic pressure on inactivation and injury of pathogens

The aim of this US research was to determine the effect of hydrodynamic pressure (HDP) treatment on the inactivation of *E. coli* O157:H7, *Salmonella* Typhimurium, and *Listeria monocytogenes* on meat surfaces. Irradiated beef cubes were inoculated with these pathogens and treated with HDP. The HDP treatment reduced *E. coli* O157:H7 (0.75 log CFU/g), *S. Typhimurium* (1.09 log CFU/g), and *L. monocytogenes* (0.55 log CFU/g). Using transmission electron microscopy they determined most cell injury occurred at the cell membrane. <http://www.sciencedirect.com/science/article/pii/S1466856411001147>

#### Atmospheric plasma technology in the meat industry

This article reviews atmospheric plasma systems, the current technology, its regulatory status and future opportunities in the meat industry. Atmospheric plasmas (APT) contain high levels of bactericidal molecules such as ozone that are generated at room temperature with minimal power, within minutes, and little or no product heating. This technology could be implemented into existing meat processing lines. It is compatible with existing sanitation practices and results in rapid decontamination of food contact surfaces. The review covered studies demonstrating the use of APT in meat and poultry processing, including in-line disinfection for food contact surfaces,

pathogen and biofilm control of ready-to-eat meat, and treatment/disinfection of package materials. While the studies were limited, result showed bacterial reductions from APT ranged between 0.5 log CFU to 6 log CFU. <http://www.foodsafetymagazine.com/article.asp?id=4205&sub=sub1>

### ANTIMICROBIAL DEGRADATION

#### Bovine intestine bacterial degradation of ceftiofur and ceftriaxone

The aim of this US research was to test if ceftiofur was degraded in the bovine intestinal tract by gut bacteria. They found that 96% of the isolates were able to inactivate ceftiofur to some degree and 54% degraded the drug. None of nine fungal isolates inactivated or degraded ceftiofur. A subset of ceftiofur degraders was also found to degrade ceftriaxone. Most of the species of bacteria that degraded ceftiofur belonged to the genera *Bacillus* and *Bacteroides*. Bacterial DNA analysis detected specific  $\beta$ -lactamase (enzymes capable of degrading antibiotics) genes, and analysis of bacterial lysates showed that  $\beta$ -lactamase enzymes were sufficient to degrade ceftiofur. These results suggest that ceftiofur is degraded by several bacteria in the large intestine of cattle by multiple  $\beta$ -lactamases.

<http://aac.asm.org/cgi/content/short/AAC.00008-11v1?rss=1>

## ANTIMICROBIALS IN BRINES

### Survival of *E. coli* O157:H7 in meat brines containing antimicrobials

This US study evaluated survival of *E. coli* O157:H7 in brines formulated with or without antimicrobials. Fourteen brine solutions were formulated. The brines were inoculated with antimicrobial resistant *E. coli* O157:H7 and stored at 4 or 15°C. The results showed immediate pathogen reductions of 1.8 to 2.4 log CFU/mL with brines containing cetylpyridinium chloride (CPC) or sodium metasilicate. Brines formulated with lactic acid, acetic acid, citric acid, nisin + EDTA, pediocin + EDTA, CPC, sodium metasilicate, or hops beta acids had reductions in pathogen levels over time (0.4 to 2.4 log CFU/mL); however, the extent of pathogen reduction depended on the antimicrobial, brine type, storage temperature and time. <http://onlinelibrary.wiley.com/doi/10.1111/j.1750-3841.2011.02300.x/abstract>

## GENETIC LINKS TO *E. COLI* O157:H7 SHEDDING

### Research seeks link between cattle genetics and *E. coli* O157:H7

USDA-funded research was undertaken to better understand the role cattle genetics may play in food contamination by *E. coli* O157:H7. Although some cows have no *E. coli* O157:H7 in their systems, other cows present a greater risk for beef contamination by shedding higher concentrations of the pathogen in their faeces. If genetic markers for supershedders of *E. coli* O157:H7, or conversely, animals that do not carry the microorganism, can be established, genetic and breeding programs can be developed to

help minimize the risk of the pathogen by selecting for the non-carriers and build up a non-shedding stock.

<http://www.meatpoultry.com/en/News/News%20Home/New%20Technology/2011/8/Research%20seeks%20link%20between%20genetics%20E%20coli%20O157H7.aspx>

## PROCESS CONTAMINATION AND CONTROL MEASURES

### Visual evaluation of carcase cleanliness correlation to microbial contamination

The aim of this Italian study was to establish whether the visual cleanliness of cattle slaughtered was correlated to hide and carcase bacterial contamination. Cattle in a slaughterhouse were visually inspected and assigned to a category from 1 (very clean) to 5 (very dirty) based on cleanliness. Fifteen animals for each category were randomly selected, hide and carcase sampled and bacterial counts completed. Results showed that increasing dirt on cattle was associated with higher bacterial counts on hide and carcasses. Carcasses classified in cleanliness categories 3, 4 or 5 had a higher probability of exceeding regulatory limits. The results support the conclusion that the pre-slaughter visual evaluation of animal cleanliness and application of corrective actions can be an effective aid to reduce carcase contamination. <http://www.sciencedirect.com/science/article/pii/S0309174011002762>

### Lower microbial counts linked to remote video auditing

A USA beef company installed a remote video auditing system (RVA) that achieved a two-thirds reduction in *E. coli* O157:H7 counts in its processing plants in the first half of 2011 versus the same period last year. The system has helped improve the overall food safety program by identifying floor employees who

need further training in food safety procedures. The RVA has helped reduce carcass contamination as part of an overall food safety program to evaluate procedures, food safety interventions and auditing.

<http://www.meatpoultry.com/News/News%20Home/Business/2011/8/CBW%20Exclusive%20JBS%20attributes%20lower%20microbial%20counts%20to%20remote%20video%20auditing.aspx>

### **Effects of shearing and fleece cleanliness on microbiological contamination**

The aim of this Norwegian study was to investigate microbiological carcass contamination associated with different shearing systems, fleece cleanliness, and the slaughter process. Swab samples were collected from the brisket areas of naturally contaminated lamb carcasses at the start of the slaughter-line, at the end of slaughter-line, and just before chilling. The lambs were divided into four groups according to the duration of the period between shearing and slaughter (0, 3, 7 days and not shorn). Results at skinning were 5.78 log CFU/100cm<sup>2</sup> and 6.95 log CFU/100cm<sup>2</sup> for aerobic plate count (APC), 1.65 log CFU/100cm<sup>2</sup> and 2.78 log CFU/100cm<sup>2</sup> for *E. coli* for shorn and unshorn lambs, respectively. Results for the four time periods for mean log CFU/100 cm<sup>2</sup> were 5.45, 5.75, 6.12 (APC) and 1.77, 1.46, 1.71 (*E. coli*) for the 0-day, 3-days and 7-days groups, respectively. The carcasses at the end of the slaughter-line had lower levels of APC than they had at skinning. However, the reduction of *E. coli* on carcass surfaces at skinning for shorn lambs were no different from the unshorn group at the end of the slaughter-line. <http://www.sciencedirect.com/science/article/pii/S0168160511004430>

### **Translocation of surface-inoculated *E. coli* onto beef striploins following blade tenderization**

USA researchers assessed if there was translocation of *E. coli* among beef loins

processed with a mechanical tenderizer. Two striploins were inoculated with 8 to 10 log CFU/ml acid-resistant *E. coli* and then processed through a tenderizer. Then six successive un-inoculated striploins were passed through the tenderizer. After tenderization, *E. coli* levels were found to be highest in the first and second loin but there were no differences in *E. coli* numbers in the last four loins. Six 1-cm cross-sections were taken through the loins. Levels of *E. coli* from section one were higher than those for all other sections. The results indicated that even after inoculation with high levels of *E. coli*, contamination from one loin to another is quickly reduced.

<http://www.ingentaconnect.com/content/iafp/jfp/2011/00000074/00000008/art00016>

### **Biofilm formation by *E. coli* O157:H7 on food-contact surfaces in beef processing**

This US study evaluated *E. coli* O157:H7 attachment, survival and growth on food-contact surfaces under simulated beef processing conditions. Sections of stainless steel and polyurethane were suspended in three substrates inoculated with *E. coli* O157:H7 and then incubated. The three substrates tested were sterile tryptic soy broth (TSB), unsterilized beef fat-lean tissue homogenate and unsterilized ground beef. The results of this study indicates that *E. coli* O157:H7 attachment was not affected by surface type but mainly influenced by the type of substrate and temperature. Attachment occurred at a temperature representative of beef fabrication areas during non-production hours (15°C), but also occurred during cold storage (4°C)

temperatures. <http://www.sciencedirect.com/science/article/pii/S0168160511003783>

## PACKAGED PRODUCT CONTAMINATION

### Evaluation of *E. coli* O157:H7 translocation and decontamination for vacuum-packaged subprimals

USA researchers measured the translocation of *E. coli* O157:H7 and tested the impact of water washing and partial or complete surface trimming as possible pathogen reduction strategies for vacuum-packaged beef subprimals. Samples were inoculated, vacuum-packed and stored for 0, 14, or 28 days. Upon removal from storage, various wash and trimming treatments were applied. Analysis after treatment revealed for both high- and low-inoculated top sirloin, contamination of adjacent and opposite surfaces occurred after vacuum-packaging. Water washing was the least effective for both high- and low-inoculated subprimals. Full trimming, with or without a water wash, proved to be the most effective treatment to reduce *E. coli* O157:H7 to non-detectable levels. <http://www.ingentaconnect.com/content/iafp/jfp/2011/00000074/00000007/art00001>

### Biochemical activities of *Brochothrix thermosphacta*

Polish scientists measured the activities of 19 enzymes in cell suspensions of 40 *Brochothrix thermosphacta* strains, isolated from meat and meat products packaged under various conditions. These strains produced various proteolytic, lipolytic and hydrolysis enzymes which may be important in meat spoilage. Thirteen of the strains displayed proteolytic activity for albumin at 4°C while nine strains showed this activity at 25°C. Only four strains digested albumin at both temperatures. The results indicate the meat spoilage potential of *Brochothrix thermosphacta* strains results not only from digestion of carbohydrates but also from their digestion of meat protein.

<http://www.sciencedirect.com/science/article/pii/S0309174011002932>

## SPOILAGE MICROBIAL COMMUNITIES OF PACKAGED PRODUCTS

### Microbial metabolites and bacterial diversity in beef stored at different packaging conditions

Italian researchers determined loads of spoilage microorganisms, microbial metabolites and microbial diversity on beef chops stored at 4°C at different packaging conditions: air (A); modified atmosphere packaging (MAP); vacuum (V); bacteriocin-activated antimicrobial packaging (AV). The results showed the microbiological shelf-life of meat increased with increasing selectivity of storage conditions. Analysis of microbial DNA showed that *Brochothrix thermosphacta* dominated during the early stages of storage in A and MAP while *Pseudomonas* sp. took over during further storage. Bacteria, were usually associated to soil rather than meat, and were identified in V and AV. However, lactic acid bacteria (LAB) dominated during later storage and *Carnobacterium divergens* was the most frequent in AV. Among the volatile metabolites, butanoic acid was associated to the growth of LAB in V and AV while acetoin was related to the other spoilage microbial groups and storage conditions. The microbiota was shown to be affected by the storage conditions and its changes during storage determine shifts in the metabolites produced with a potential impact on meat quality.

<http://aem.asm.org/cgi/content/abstract/AEM.05521-11v1>

### Spoilage-related activity of *Carnobacterium maltaromaticum* strains in air-stored and vacuum-packed meat



Italian researcher's identified 103 isolates of *Carnobacterium* spp. from raw meat by 16S rRNA gene sequencing. Forty-five strains of *C. maltaromaticum* were characterized for their growth capability at different temperatures, NaCl concentrations and pH values and for in vitro lipolytic and proteolytic activities as well as release of volatile organic compounds (VOC) in air and vacuum-packed meat. The measurements showed all the meat samples inoculated and stored in air showed a higher number of VOCs than the vacuum-packed meat samples. The contaminated meat samples were evaluated by a sensory panel; the results indicated that for all sensory odours no effect of strain was significant. The storage conditions affected the perception of odours that were more intense in meat stored in air than vacuum pack. They concluded different strains of *C. maltaromaticum* can efficiently grow in meat stored at low temperatures both in air and vacuum pack, producing volatile molecules with low sensory-impact with an overall negligible contribution to meat spoilage. <http://aem.asm.org/cgi/content/short/AEM.05304-11v1?rss=1>

### **Identification of the spoilage status of minced beef**

European scientists assessed the shelf-life of minced beef stored aerobically, under modified atmosphere packaging (MAP), and under MAP with oregano essential oil (MAP/OEO) at 0, 5, 10, and 15°C by high performance liquid chromatography (HPLC). Microbiological analyses included total viable counts (TVC), *Pseudomonas* spp., *Brochothrix thermosphacta*, lactic acid bacteria, *Enterobacteriaceae*, and yeasts/moulds. Sensory assessment was also performed, pH and HPLC analysis of the organic acid profiles. Statistical analysis of HPLC data revealed qualitative discrimination of the samples based on their spoilage status. Partial least squares regression (PLS-R) analyses correlated predicted bacterial

populations to the microbiological analyses. The results showed HPLC measurement of organic acids was found to be a potential method to evaluate the spoilage and microbial status of a meat sample regardless of the storage conditions. <http://www.sciencedirect.com/science/article/pii/S0168160511004028>

### **Physiochemical and microbial attributes of organic acid infused beef cuts**

This study was carried out to determine the effect of infusing food grade organic acids on the shelf-life of fresh beef kept at refrigeration temperatures. Citric, lactic, acetic and tartaric acids were infused into fresh beef slices. Samples were dried and stored at 5°C for 28 days. The pH value of the treated samples dropped from 5.3 to around 4.3 and the total plate count values were  $<1 \times 10^7$  CFU/g on day 16, 20 and 28 in samples treated with organic acids. The instrumental texture of the treated samples was harder upon treatment, which decreased gradually during the storage period. The conclusion from this study was that the shelf-life of treated beef was extended to 12–24 days and 1% citric acid produced the best effect. <http://onlinelibrary.wiley.com/doi/10.1111/j.1745-4565.2011.00304.x/abstract>

## **DETECTION TECHNOLOGY**

### **Monitoring of ATP and viable cells on meat surfaces by UV-Vis reflectance**

Scientists developed a rapid technique to monitor adenosine triphosphate (ATP) (an indicator of bacterial metabolism) levels and viable cells based on non-destructive UV–Vis reflectance. Meat samples stored at 15°C were analysed at 0, 24, 48, 72, 84 and 96 hours for ATP, plate count and UV–Vis reflectance. The plate count on the sample surface increased from the initial count after

84 hours. The level of ATP also increased with time from the initial amount after 84 hours. A correlation was observed between ATP level and plate count. Further analysis of raw spectra gave a high correlation for the first 48 hours for both ATP level and viable cell count. The results of this study suggest that the UV–Vis reflectance spectrum analysis could be used as for real-time monitoring of ATP and/or plate count on meat surface using an optimal wavelength.

<http://www.sciencedirect.com/science/article/pii/S0260877411003086>

## **E. COLI O157:H7 VACCINE REVIEW**

### **A review of vaccinations to reduce the shedding of *E. coli* O157**

The objective of this Canadian study was to review and conduct a meta-analysis of published literature evaluating the efficacy of vaccines to reduce faecal shedding of *E. coli* O157 in ruminants. The search located 20 relevant manuscripts that detailed 24 trials and 46 treatment comparisons; all but one trial involved cattle. There were nine deliberate challenge trials, and 15 natural exposure trials. Meta-analysis of type III protein vaccine comparisons revealed that vaccine treatment resulted in reducing *E. coli* O157 faecal prevalence. Siderophore receptor and porin protein vaccines also reduced faecal shedding; however, none of the bacteria vaccine trials resulted in a significant reduction in prevalence. The authors suggest caution should be taken in interpretation because of the heterogeneity found in the results.

<http://onlinelibrary.wiley.com/doi/10.1111/j.1863-2378.2011.01426.x/abstract>

## **INDICATOR ORGANISM REVIEW**

### **Indicator organisms in meat and poultry slaughter operations - a review**

This USA review discusses the use of non-pathogenic organisms on poultry products used for designing process control systems. These measurements could result in reductions of pathogen levels and be flexible for use with emerging technologies in meat processing. They determined sufficiently frequent measurements would be needed to help identify processing deficiencies and the correct balance of sampling and resources would be determined by characteristics of deficient processing. They recommend strategies that emphasize flexibility so coupling the measurement of levels of indicator organisms with emerging technologies and suitable on-site platforms. This would decrease the time between sample collection and interpreting results to enhance monitoring process

control. <http://www.ingentaconnect.com/content/iafp/jfp/2011/00000074/00000008/art00026>

## REGULATORY ASSESSMENT OF LACTIC ACID TREATMENT

### **ESFA evaluation of lactic acid for the removal of microbial surface contamination of beef carcasses**

The ESFA assessed studies evaluating the safety and efficacy of lactic acid treatment for decontamination of beef carcasses, cuts and trimmings. Treatments that were considered included 2 % to 5 % lactic acid solutions at temperatures of up to 55°C. The ESFA report concluded that these treatments pose no safety concerns provided that the lactic acid complies with EU specifications for food additives. Treatments that were not considered were water rinses after lactic acid treatment. The evaluation concluded the

microbial reductions were significant with this treatment even though there was variation in lactic acid concentration and temperature between studies. The report also concluded there was a low risk of environmental contamination as the lactic acid concentration before entering the wastewater treatment system was negligible. However, It was recommended that during use, business operators verify lactic acid concentration, temperature of application and other factors affecting its efficacy as a decontaminating agent and validate the antimicrobial efficacy under their specific processing conditions. <http://www.efsa.europa.eu/en/efsajournal/pub/2317.htm>

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