

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

PACKAGING TECHNOLOGY

Antimicrobial packaging to retard the growth of spoilage bacteria

The aim of this Italian research was to evaluate the effect of the antimicrobial packaging (nisin-EDTA solution) on vacuum-packed beef stored at 1°C. The active packaging was found to slow down the growth of lactic acid bacteria. *Brochothrix thermosphacta* was not found over the storage time, while the levels of *Carnobacterium* spp. were below the detection limit for the first 9 days and reached loads below 5 log CFU/cm² after 46 days.

Enterobacteriaceae and *Pseudomonas* spp. were not affected by the antimicrobial packaging and grew in all of the samples to 4 log CFU/cm². Of the strains isolated at day 36, all were identified as *Carnobacterium divergens*. The microbial metabolic activity was affected by the use of the antimicrobial film from the start up to 36 days with a maximum difference of volatile metabolites in samples analysed at 20 days. It was concluded that the active packaging reduced the spoilage microbial populations and the release of metabolites in the headspace of beef, with a positive impact on meat quality.

<http://www.ingentaconnect.com/content/afp/jfp/2013/00000076/00000001/art00007;jsessionid=3kd8crb2eaa91.alice>

Consumer acceptance of modified atmosphere packaging

The objective of this USA study was to assess whether consumers would accept modified atmosphere packaging (MAP) with the inclusion of carbon monoxide (CO-MAP) and what value consumers place on ground beef packaged under various atmospheres using the attributes of colour and shelf-life. The results indicated that consumers preferred an extension of shelf-life as long as the applied technology was known and understood. Consumers had clear preferences for brighter (aerobic and CO) red colour and were willing to pay \$US0.35/kg for an increase level of change to the colour. Too much information on MAP for extending the shelf-life and on CO-MAP for stabilising colour decreased consumers' willingness to pay. An increase in personal knowledge and media exposure influenced acceptance of CO-MAP negatively. The results provided quantitative measures of how packaging affects consumers' acceptance and willingness to pay for products.

<http://www.ingentaconnect.com/content/afp/jfp/2013/00000076/00000001/art00014;jsessionid=3kd8crb2eaa91.alice>

SOURCES OF CONTAMINATION

Transfer of verotoxigenic *E. coli* during sheep slaughter

The purpose of this UK study was to investigate carriage and transfer of verotoxigenic *E. coli* (VTEC) O157, O26, O111, O103 and O145 from fleece to dressed carcasses. Sheep (n = 500) were sampled (10 g of fleece, plus a full carcass swab) through the slaughter process. Samples were examined for the presence of verotoxin (vt1 and vt2) genes using a PCR assay and positive samples were further screened for the presence of the chosen five serogroups by real-time PCR. VTEC O26 was recovered from 5/500 (1.0%) fleece and 2/500 (0.4%) carcass samples. VTEC O157 was isolated from 4/500 (0.8%) fleece samples and 3/500 (0.6%) carcass samples. *E. coli* O103 was recovered from 84/500 (16.8%) fleece and 68/500 (13.6%) carcasses. O145 was recovered from one fleece sample, but it did not carry vt genes. O111 was not detected in any samples. For the four serogroups recovered, the direct transfer from fleece to carcass was not observed, showing that VTEC O26 isolates from a matched fleece/carcass "pair" were not identical. This study shows that while VTEC O157 are being carried by sheep presented for slaughter in Ireland, other potentially clinically significant verotoxin producing strains (particularly VTEC O26) were present.

<http://www.sciencedirect.com/science/article/pii/S0740002012002584>

Sources of *E. coli* deposited on beef during breaking of carcasses

Canadian researchers obtained microbiological samples from the hands of workers, personal equipment and

conveyor belts in the carcass breaking facility of a beef packing plant to determine sources of contamination. Before work started, steel mesh gloves carried coliform and *E. coli* counts of 4 and 3 log cfu/25 gloves, respectively, while counts on conveyor belts were >2 and <2 log cfu/2500 cm², respectively. After a work shift, the numbers of both coliforms and *E. coli* on steel mesh gloves and conveyor belts were reduced by about 1 log unit. The findings indicated that the proximate source of most coliforms and *E. coli* that contaminate cuts and trimmings were, in order, cotton gloves and conveyors. In a second study using rubber gloves placed over cotton ones prevented contamination from cotton gloves. The conveyor belt carried coliforms and *E. coli* at numbers about 1 cfu/cm² and >1 cfu/100 cm², respectively, before work started; and at numbers < 1 cfu/cm² and about 1 cfu/100 cm², respectively, after the period of work to process a lot of carcasses. The findings in this study indicated that both cuts and trimmings are contaminated with coliforms and *E. coli* primarily from the conveyor.

<http://www.sciencedirect.com/science/article/pii/S0956713512005452>

E. COLI O157 SHEDDING

Effects of between- and within-host variability on *E. coli* O157 shedding

The variability in the *E. coli* O157 shedding level between animals (between-host variability), as well as fluctuations in the level shed by a single animal (within-host variability), is difficult to interpret. Hence, to explain the relative contribution of between- and within-host variability to shedding patterns, USA researchers developed a model. The model integrates individual animal data

on faecal shedding over time, with pen-level *E. coli* O157 transmission to determine how the temporal (and aggregation) patterns of *E. coli* O157 shedding loads and prevalence arise. They found that even without between-host variability, the prevalence of animals with concentrations of *E. coli* O157 in faeces that exceeded 10^4 CFU/g was similar to that observed in other field data. They also found both within-host and between-host variability can result in super-shedders.

<http://www.sciencedirect.com/science/article/pii/S0167587712003030>

Diversity of *E. coli* O157:H7 isolates from super-shedders and low-shedders

This Canadian study investigated relationships among faecal and perineal hide (PS) isolates from super-shedders and low-shedder pen-mates using pulsed-field gel electrophoresis (PFGE), and DNA fingerprinting technique. Samples were taken at entry to the feedlot (sampling 1) and prior to slaughter (sampling 2). One steer maintained super-shedder status at both samplings, and approximately 30% of super-shedders in sampling 1 had low-shedder status at sampling 2. Genetic similarity among the isolates was not associated with shedding status (super- or low-shedder). Only 2/21 super-shedders had faecal isolates in the same genetic group at both samplings. Faecal and PS isolates from individual super-shedders generally belonged to different genetic groups, although faecal isolates of *E. coli* O157:H7 from super- and low-shedders showed greater similarity than those from PS. For 77% of super-shedders, DNA profiles of faecal and PS isolates were distinct from low-shedder faecal isolates collected in the same pen. A low level of antimicrobial resistance

(3.7%) was detected, and prevalence of antimicrobial resistance did not differ among super- and low-shedder isolates. The results demonstrated that DNA and genetic profiles of *E. coli* O157:H7 from individual super-shedders varied over time and that only 1/162 steers remained a super-shedder at both samplings. Subtypes of *E. coli* O157:H7 from faecal isolates of super- and low-shedders were different as were subtypes of faecal and PS isolates from super-shedders.

<http://www.biomedcentral.com/1746-6148/8/178/abstract>

SPOILAGE RESEARCH

Effect of respiration on spoilage caused by *Leuconostoc gasicomitatum*

In this Finnish study, they investigated meat respiration effects on *Leuconostoc gasicomitatum* growth rate, biomass, gene expression and volatile organic compounds (VOC) production. They observed that functional respiration increased the growth (rate and yield) of *L. gasicomitatum* in laboratory media with added heme (ferrous molecule in blood), and *in situ* meat with endogenous heme added. Respiration increased the accumulation of acetoin and diacetyl (x2600) which are buttery off-odour compounds in meat. Gene analyses showed that the gene expression patterns were similar regardless of whether respiration was stopped experimentally. They concluded respiration is a key factor in explaining why *L. gasicomitatum* is so well adapted in high-oxygen packed meat.

<http://aem.asm.org/content/early/2012/11/28/AEM.02943-12.short?rss=1>

Compounds associated with microorganisms in blown pack spoilage

This Brazilian study correlated the composition of the spoilage bacterial flora with the main gaseous and volatile organic compounds (VOCs) found in spoiled, chilled, vacuum-packed beef. More than 50% of the bacteria were identified as lactic acid bacteria (LAB), followed by clostridia and enterobacteria. The major spoilage compounds were identified as alcohols and aldehydes. CO₂ was identified as the major gas in the spoiled samples. Hence, different species of lactic acid bacteria contributed to the production of major volatile compounds during meat spoilage.
<http://onlinelibrary.wiley.com/doi/10.1111/lam.12004/abstract>

Air-liquid interface biofilm formation by pseudomonads

In this European paper, they assessed the ability of *Pseudomonas* bacteria, isolated from vacuum-packed meat, to colonise the surface of liquids, as well as biofilm formation at the meniscus and air-liquid (A-L) interface. Sixty isolates were recovered from vacuum-packed venison, of these, 12% were found to produce biofilms limited to the meniscus region of the microcosm walls. 31% produced attached biofilms with extensions across the A-L interface, and 45% produced unattached 'floating' biofilms. Statistical analysis of growth, biofilm strength and attachment levels showed that growth affected strength but not attachment, and that there was a significant relationship between attachment and strength. This survey suggested that biofilm formation may be more common in psychrotrophic meat-associated isolates than amongst the wider pseudomonad community from which spoilage bacteria might be found.

Aggregations of bacteria may be more resistant to competition and dehydration stress than individual bacteria.

<http://www.springerlink.com/content/v00g0701k1454198/>

Reduction of spoilage of chilled vacuum-packed lamb

New Zealand researchers investigated methods to reduce lamb spoilage caused by psychrotolerant *Clostridium* species, including exposure to air, hot and cold water spray washing, and tyndallisation (i.e. heating products to high temperatures for short time periods over three days to germinate bacterial spores and kill the resulting vegetative cells). Initially vegetative cells of psychrotolerant clostridia associated with spoilage of chilled vacuum-packed meat were exposed to aerobic cooked meat medium at room temperature (21°C) to determine how long they remained viable. Survival of strains varied from 2 hours to 3 days. Vegetative cells of *Clostridium estertheticum* subsp. *estertheticum* survived 7 days at 10°C with little reduction in viable numbers. Hence, exposure to air was ruled-out as a method of spoilage reduction. Trials were also carried out on chilled vacuum-packed lamb inoculated with spores of *C. estertheticum* subsp. *estertheticum*. The time until inoculated packs reached the loss of vacuum, varied from 38 to 53 days. Hot and cold water washing extended the shelf life by 12 and 13 days respectively in comparison to untreated packs.

<http://www.sciencedirect.com/science/article/pii/S0309174012003282>

AERIAL MICROBIAL SURVEYS

Detection of *E. coli* O157:H7 and *Salmonella enterica* in air and droplets

To determine if airborne *E. coli* O157:H7 and *Salmonella enterica* were present in beef processing plants, US researchers placed sedimentation sponges at various locations in beef plants that processed cattle from slaughter through fabrication. In the slaughter area, of the 291 samples, *E. coli* O157:H7 was isolated from 15.8% and *S. enterica* from 16.5% of samples. In the evisceration area, of the 113 samples, *E. coli* O157:H7 was isolated from only one sample, and *S. enterica* was not isolated. Pathogens were not isolated from any of the 87 air samples from fabrication areas. Pathogen prevalence, aerobic plate counts, and Enterobacteriaceae counts were highest for samples obtained from locations near hide removal operations. Further sampling was undertaken in this area to compare hide removal locations that were close enough to be contacted by droplets and from locations that were not contacted by droplets. Higher pathogen prevalence, aerobic plate counts, and Enterobacteriaceae counts were observed at locations with samples contacted by the hide-removal droplets. Hence, they concluded that the hide removal processes may introduce pathogens into the air via a dispersion of liquid droplets. <http://www.ingentaconnect.com/content/iafp/jfp/2012/00000075/00000012/art00015;jsessionid=32wajngr4f8md.al exandra>

Comparison of aerial counts at different sites in abattoirs

This UK study examined and compared levels of aerial contamination in commercial beef and sheep plants at four locations: lairage, hide/fleece pulling, evisceration and chilling. The levels of aerial contamination were similar at equivalent sites in beef and sheep plants, irrespective of the sampling method or the type of organisms recovered. Mean log counts for TVC, coliforms and Enterobacteriaceae in the chillers were generally lower than the corresponding mean log numbers recovered at the other three sites. Further studies in an experimental plant compared counts recovered from the neck of beef carcasses with air-suspended counts, determined with agar and irradiated meat pieces. No correlation was found between counts on beef carcasses and in the air, irrespective of the method used to compare counts.

<http://www.sciencedirect.com/science/article/pii/S0740002012001542>

TREATMENTS FOR MICROBIAL CONTROL

Quercetin dietary supplementation may reduce microbial growth

The aim of this Spanish study was to examine the effects of flavonoids on meat quality attributes. Thirty-two Merino lambs fed straw and a concentrated formula either containing palm oil (CTRL) plus quercetin (QCT) or flaxseed (FS) plus quercetin (FS-QCT), were used. Cuts were stored at 4°C and sampled at 0, 3 and 7 days. Chemical composition of longissimus thoracis (LT) muscle was not different among treatments. The longissimus lumborum (LL) samples of QCT and FS-QCT groups revealed lower discolouration when compared to the CTRL and FS lambs, whereas extract

release volume and microbiological data suggested that flaxseed and quercetin (FS-QCT) may reduce the growth of microbial populations responsible for meat spoilage in quadriceps femoris (QF).

<http://www.sciencedirect.com/science/article/pii/S0309174012003026>

Evaluation of carvacrol for the control of *E. coli* O157

Irish researchers assessed the antimicrobial activity of carvacrol (an essential oil of oregano) against *E. coli* O157 on cattle hide and carcass cuts. Carvacrol (0, 10, 20, and 30 mg/mL) was applied to cattle hide and beef carcass cuts that had been inoculated with a cocktail of *E. coli* O157 (5–6 log₁₀ CFU/cm²) and left in contact for 10 min. Carvacrol at 30 mg/mL reduced inoculated *E. coli* O157 on hide and cuts 1.4 and 1.58 log₁₀ CFU/cm², respectively, compared to the no-wash and water-wash controls. This preliminary study shows that carvacrol has the potential to control *E. coli* O157 on bovine hide and carcass cuts, but further research with larger scale trials is needed.

<http://online.liebertpub.com/doi/abs/10.1089/fpd.2012.1224>

Sensitivity of nSTEC and *Salmonella* to lactic acid on trimmings

The aim of this US study was to determine whether lactic acid treatments used to reduce *E. coli* O157:H7 on beef trimmings were also effective in controlling non-O157 Shiga toxin-producing *E. coli* (nSTEC), and *Salmonella*. Beef trimmings pieces were inoculated (3 log CFU/cm²) with *E. coli* O157:H7, O26, O45, O103, O111, O121, and O145, with each serotype mixture made-up of 4 strains. A second set of trimmings were separately inoculated

with *E. coli* O157:H7, *Salmonella* Newport and *Salmonella* Typhimurium. The inoculated trimmings were left untreated (control) or were immersed for 30 seconds in 5% lactic acid solutions (25 or 55°C). Both *E. coli* O157:H7 and nSTEC were reduced by 0.5 to 0.9 (25°C lactic acid) and 1.0 to 1.4 (55°C lactic acid) log CFU/cm². Counts of *Salmonella* on treated trimmings were not influenced by serotype or antibiotic resistance phenotype and were similar or lower than counts of *E. coli* O157:H7. The results indicated that lactic acid treatments used against *E. coli* O157:H7 on beef trimmings should be similarly or more effective against the six nSTEC serogroups and *Salmonella* Newport and *Salmonella* Typhimurium.

<http://www.ingentaconnect.com/content/afp/jfp/2012/00000075/00000010/art00004;jsessionid=25yc8y2gptxx7.victoria>

VACCINATION MODEL

A model to evaluate risks and benefits of *E. coli* vaccination in cattle

US researchers developed a stochastic simulation model to evaluate the impact of *E. coli* O157:H7 vaccination on key epidemiological outcomes. The model evaluated a reduction in the O157 prevalence in feedlot cattle as well as concentration in cattle faeces due to vaccination. The results showed that vaccination can have a significant benefit such as reduction in (1) the number of human O157 illnesses due to the consumption of ground beef, (2) the number of production lots with high O157 contamination levels, (3) the likelihood of detection by USDA Food Safety and Inspection Service testing, and (4) the probability of multiple illnesses due to ground beef servings from the same lot. These results showed that these

outcomes are most strongly impacted by pre-harvest vaccination. <http://online.liebertpub.com/doi/abs/10.1089/fpd.2012.1150>

REGULATORY NEWS

EU Parliament approves use of lactic acid

European Union ministers gave approval for the use of lactic acid as a decontaminant in beef processing. The process has been described as safe by the European Food Safety Authority

(EFSA). Consumer groups said if chemicals such as lactic acid were allowed, their use should be made transparent for consumers. Shoppers should be able to rely on clear labels telling them whether or not their meat has been chemically treated. France, Greece, Latvia, Austria and Poland voted against the decision.

<http://www.themeatsite.com/meatnews/19616/eu-gives-go-ahead-to-lactic-acid-in-meat-processing>

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