

## MEAT

### **SURVIVAL AND GROWTH OF *ESCHERICHIA COLI* O157:H7 IN ROAST BEEF AND SALAMI AFTER EXPOSURE TO AN ALKALINE CLEANER** (M. Sharma, G. M. Richards, and L. R. Beuchat)

Dry, fermented salami and sausage have been implicated as vehicles in outbreaks of enterohemorrhagic *Escherichia coli* (EHEC) infections. Exposure of foodborne pathogens to acid or alkali stress may cross protect cells against other stresses. Highly alkaline cleaners are used to clean smokehouses, commercial ovens, and high pressure and mechanized systems. The widespread use of these cleaners in pre- and post-processing environments may result in adaptation of foodborne pathogens to alkaline pH and cross protection to subsequent stress environments. The objective of this research was to determine the survival characteristics of *E. coli* O157:H7 cells exposed to alkaline cleaners, inoculated into sliced roast beef and hard salami, and stored at various temperatures. The *rpoS* gene was examined for its role in initiating mechanisms resulting in the protection of cells against treatment with alkaline cleaner and subsequently promoting survival and growth in roast beef and salami.

Survival and growth of wild-type (EDL 933) and *rpoS*-deficient (FRIK 816-3) strains of *E. coli* O157:H7 after exposure to an alkaline cleaner for 2 min and inoculation into roast beef (pH 6.3) and hard salami (pH 4.9) at low (0.003 – 0.52 cfu/g) and high (0.69 – 31.5 cfu/g) populations were determined. Roast beef was stored at 4 and 12°C; salami was stored at 4, 12, and 20°C. At 4°C, untreated cells of both strains showed greater reductions in populations in salami than in roast beef during a 21-day storage period. Populations of treated and untreated cells recovered from roast beef and salami stored at 4°C on tryptic soy agar were significantly ( $P \leq 0.05$ ) higher than on sorbitol MacConkey agar, indicating that a portion of the cells was injured. Treated and untreated cells grew in roast beef at 12°C. Growth of treated cells of the FRIK 816-3 strain in roast beef at 12°C was significantly slower than that of the EDL 933 strain. Populations of both strains decreased at different rates in salami stored at different temperatures (20°C > 12°C > 4°C). *E. coli* O157:H7 strain EDL 933 grew more rapidly at 20°C in a slurry (pH 5.97) prepared from stored salami (17 days at 20°C) on which *Penicillium chrysogenum* had grown than in slurry (5.23) prepared from salami showing no mold growth. Within 2 - 3 days, populations were ca. 3 log cfu/ml higher in slurry made from infected salami compared to control salami. Results indicate that treatment of *E. coli* O157:H7 with an alkaline cleaner for 2 min does not impair resuscitation and growth of surviving cells in roast beef at 12°C. Cross protection of cells exposed to an alkaline cleaner against subsequent stress conditions imposed by roast beef and salami stored at 4°C was not evident in either of the test strains.

### **THE ROLE OF AEROSOL IN TRANSMISSION OF MICROORGANISMS (INCLUDING *LISTERIA*) TO READY-TO-EAT MEAT/POULTRY PRODUCTS.** (L. Ma, C. M. Lin, Z. Yan, J. Kornacki, O. Oyarzabal, and M.P. Doyle)

Airborne contamination of *Listeria monocytogenes* in food processing facilities may or may not be an important contributing factor in disseminating *L. monocytogenes* in such facilities. However, aerosol studies in food processing plants have been limited by lack of a suitable surrogate microorganism for *L. monocytogenes*. The objectives of this study were to investigate the potential of using *Jonesia denitrificans* as a surrogate for aerosol studies of *L. monocytogenes* and to study the role of aerosols in the transmission of microorganisms (including *L. monocytogenes*) to ready-to-eat meat/poultry products.

The settling rates of aerosol-borne *J. denitrificans* released into a bioaerosol chamber were determined. Studies revealed that settling rates depend on particle size and relative humidity of the environment. Larger particles settled from the air more rapidly than smaller particles, with 5- $\mu$ m particles completely settled out of the air within a few minutes of releasing and 0.3- $\mu$ m particles remaining

airborne (<1 log<sub>10</sub> reduction) for 4 hours. In most instances, relative humidity (RH) at 40 or 75% had minimal effect on settling rates, although settling rates of *J. denitrificans* were slightly greater at 75% RH than at 40% RH. Overall, *J. denitrificans* had similar settling rates as *L. monocytogenes* (previous studies).

The contamination level of *J. denitrificans* on turkey meat following its aerosolization in the bioaerosol chamber was similar to that of *L. monocytogenes* which was dependent on initial inoculum cell numbers, exposure time, and relative humidity. The greater the number of cells in the aerosol, the greater the number of contaminated turkey samples and the less exposure time for contamination to occur. No turkey samples were *J. denitrificans* or *L. monocytogenes* positive within 4 hours exposure time when the initial cell number was  $\leq 2.5 \times 10^2$  or  $\leq 1.5 \times 10^2$  cfu/L air, respectively, and all samples were positive within 5 to 30 minutes of exposure when cell inoculum populations were  $\geq 3.5 \times 10^5$  cfu/L air. More samples were positive in the 75% RH environment when the inoculum was  $10^3$  cfu/L air but relative humidity had little influence on the number of contaminated samples for higher or lower levels of inoculum. Both the detectable cell numbers of *J. denitrificans* and *L. monocytogenes* on positive samples of non-cured turkey meat were generally low, ranging from 1 to 12 cfu per three slices. These results suggest that even when relatively large cell numbers are in the aerosols in a room, relatively small numbers contaminate the surface of products during a short exposure.

Releasing *J. denitrificans* at  $10^3$  cfu/L as an aerosol into a deboning room of a poultry processing pilot facility revealed that the distance from the air conditioning units from which the bacteria were aerosolized influenced the level of *J. denitrificans* contamination that occurred. The greatest degree of contamination occurred at 100 to 150 cm from the air conditioners, and least at 50 and 250 cm from the units. For samples obtained at 100 cm, the greatest average number of *J. denitrificans* on agar media was  $2.4 \times 10^2$  cfu/plate, and greatest percentage of meat samples positive at a sampling distance was 40%. Results indicate that releasing as an aerosol at a high population ( $10^3$  cfu/L), *J. denitrificans* can contaminate agar plate and meat surfaces at a range of 250 cm from air conditioning units with the greatest degree of contamination occurring within 100 to 150 cm of an air conditioning unit. Interestingly, swab sampling of environmental surfaces of the deboning room immediately after aerosolizing *J. denitrificans* yielded negative results; indicating *J. denitrificans* is not a good environmental survivor.

#### **FATE OF ACID-ADAPTED AND NONADAPTED *ESCHERICHIA COLI*, *LISTERIA MONOCYTOGENES*, AND *SALMONELLA* ON GROUND OR WHOLE BEEF JERKY** (R. A. Morrow, M. A. Harrison, and J. A. Harrison)

The objective of this study was to determine the fate of acid-adapted and nonadapted *Escherichia coli* O157:H7, *Salmonella*, and *Listeria monocytogenes* on ground and whole beef jerky strips during the home-style jerky process. Each organism and meat type was compared separately and analyzed using a split-plot experimental design. To achieve acid-adapted and nonadapted cultures, each pathogen was grown in tryptic soy broth with and without dextrose, respectively. After incubation, the pH of the acid-adapted culture was 4.88 and the nonadapted was 6.97. Inoculated strips were dried in a vertical dehydrator with an air temperature of 60.0°C. For ground beef strips, samples were taken at time 0, 2, 4, 6, and 10 h. After 10 h, population reductions of acid-adapted and nonadapted *E. coli* O157:H7, *Salmonella*, and *L. monocytogenes* were 5.86 and 5.30, 4.73 and 3.96, and 4.28, and 4.51 log<sub>10</sub>, respectively. When population reductions were compared for the same organism, there was no significant difference ( $p > 0.05$ ) between acid-adapted and nonadapted *E. coli* O157:H7, *Salmonella*, and *L. monocytogenes* on ground beef strips. Whole beef strips were sampled after inoculation, after marination, and at 4, 8, 12, and 14 h. Population reductions after 14 h for acid-adapted and nonadapted *E. coli* O157:H7, *Salmonella*, and *L. monocytogenes* were 5.25 and 5.13, 4.85 and 4.82, and 4.81 and 4.87 log<sub>10</sub>, respectively. When population reductions were compared for the same organism, there was no significant difference ( $p > 0.05$ ) between acid-adapted and nonadapted *E. coli* O157:H7, *Salmonella* and *L. monocytogenes* on whole beef strips.

