



On the

# Cutting Edge



APRIL 2003

OSU MEATS EXTENSION FACT SHEET  
BY LYNN KNIPE AND HENRY ZEBBY

## E. coli Reassessment for Beef Slaughter Processes

Based upon the following data, beef slaughter process interventions that are most effective in reducing *E. coli* 0157:H7 include:

**Carcass wash** (90 to 105°F, 300 psi), prior to any of the following pasteurization procedures (using a portable spray unit) (Colorado State research)

Followed by either

**Hot water pasteurization** – 165°F for 5-10 sec.  
160°F, 10-20 sec.

or

**Acid Rinse** – 2% acetic acid or 2% lactic acid at 110-130°F (both acid treatments work best on warm carcasses)

### Summary

The initial warm carcass wash is important to assist in removal of as much organic matter (hair, blood, etc.) from the carcass as possible before continuing with the hot water or acid rinses. The warm (90-105F) water temperature is also important to keep the carcass surface warm in the event that an acid rinse will follow. Research has shown that the higher the pressure that is used to spray the warm water the better. While 300 psi might be difficult for some to obtain, the portable spray units that some small processors have should reach that level of pressure. It is important that steps be taken to prevent this high pressure warm water treatment from blowing fecal contamination all over the slaughter floor. This can be prevented by proper training for those using the sprayer and/or the use of some type of panels or walls to surround the carcasses while being washed.

Hot water pasteurization has been shown to be an effective means to reduce *E. coli* levels on beef carcasses, however, it may be difficult to use water of this temperature on carcasses in some plants. Perhaps, the easiest method to reduce pathogens, after the carcass wash, would be the use of an organic acid rinse.

Acetic acid would be recommended over lactic acid at this time, due to its availability and safety of use. Initially, we would recommend that you use vinegar from a grocery store (5-8% acetic acid), and dilute it to a 2% concentration.

The following summaries of scientific publications support the use of these *E. coli* intervention strategies, as well as other strategies that are not recommended.

### Supporting Scientific Publications

#### Trimming

- Trimming reduced *E. coli* 0157:H7 population by 3.1 logs (5.14 logs initial), whereas, trimming combined with a warm water wash (35°C/95°F) reduced *E. coli* 0157:H7 by 4.7 logs (5.19 logs initial). *Phebus, et al., 1997, J. Food Prot. 60(5):476-484.*

#### Acetic Acid

- When 2% acetic acid was sprayed onto beef brisket fat for 12 sec., immediately after being inoculated with fecal matter, *E. coli* was reduced by 3.69 logs. When there was a 2 hr. delay between inoculation and application of 2% acetic acid solution, *E. coli* levels were reduced significantly less, at 2.5 logs (which was not significantly different from the use of 35°C/95°F water, but significantly less reduction than when 74°C/165°F water was used.) *Cabedo, Sofos and Smith. 1996. J. Food Prot. 59(12):1284-1287.*

#### Chlorine

- 50 ppm chlorine (at 25°C/77°F) sprayed on pork carcasses reduced *S. typhimurium* by 2.25 logs (equal to the reduction with a 2% lactic acid rinse). When a hot water wash (10 sec) was applied after the chlorine rinse, *S. typhimurium* was reduced an additional 2.5 logs. N. Clayton, 2002. Unpublished thesis from U. Kentucky.
- Reduced total aerobic counts on beef forequarters from 3,000/cm<sup>2</sup> before wash, 100/cm<sup>2</sup> 45 min. after wash and 27/cm<sup>2</sup> 24 hrs after 200 ppm chlorinated (*generated electrolytically*) water wash. Increasing spray pressure from 4.2 kg/cm<sup>2</sup> to 24.6 kg/cm<sup>2</sup> caused significant reductions in counts, to levels comparable to low pressure, high temperature (51.7°C) wash. *Kotula et al., 1974, J. An. Sci.39(4):674-679.*
- Strips of beef plates treated with 200-250 mg/L sodium **hypochlorite (Chlorox)** resulted in a mean decrease in counts of 0.43 logs, and counts increased over 48 hrs., showing no residual effect. The higher pressure treatment (14.0 kg/cm<sup>2</sup>) resulted in a larger reduction (0.47 logs) than the lower pressure treatment (3.5 kg/cm<sup>2</sup>). Unpublished data showed that significantly less growth occurred on hypochlorite-treated carcasses that were not washed prior to the treatment, suggesting that the water wash diluted the hypochlorite, reducing its effectiveness. *Anderson, M. E. 1977. J Food Sci. 42 (2):326-329.*

- 80°C (176°F) water rinse was approx. equivalent to 95mg/L chlorine at 55°C (131°F) in reducing aerobic plate counts on lamb carcasses (> 1 log reduction). Greater reductions were found at either 65 (149°F) or 80°C, using 30 mg/l chlorine. *Kelly, et al. 1981. J. Appl. Bacteriol. 51:415-424.*

**Hot Water**

- A hot water wash (74°C/165°F at 20 psi, followed by 30°C/86°F at 125 psi water), reduced *Listeria innocua* on beef carcasses by 2.5 logs. This same water wash treatment reduced *E. coli* MARC1-s by 2.6 logs. *Dorsa, Cutter and Siragusa,*
- A hot water treatment (53°C/127°F) for 10 s resulted in the greater reduction of *S. typhimurium* on pork carcasses, than a 10 s flame singe, 50 ppm chlorine or 2% lactic acid, with a 3.7 log reduction. A second hot water rinse (53°C/127°F) further reduced *S. typhimurium* counts by an additional 1 log. *N. Clayton, 2002. unpublished thesis from U. Kentucky*
- Hot water (74C/165F, for 20s at 20.7 bar) was claimed to be more effective in reducing *E.coli* contamination (4.2 log reduction) than either organic acids or cooler water, however, the reduction was not significantly different (P> 0.05) than that for 35°C water, 5% hydrogen peroxide, and 2% acetic acid. *Cabedo et al., 1996. J. Food Prot. 59(12) 1284-1287.*
- Beef brisket adipose tissue inoculated with 6.3 log CFU of *E. coli* per cm<sup>2</sup> treated with 74°C (165°F) water wash, followed by a 16°C (61°F) water wash, resulted in a 3-log reduction. However, if reversed in order (16°C water wash, followed by 74°C water wash), *E. coli* was reduced by only 2.6 logs. *Gorman et al. 1995 J Food Prot. 58:899-907*
- Sheep carcass surfaces submersed in 80°C (176°F) water for 10 s reduced *E. coli* by 3.3 log (6-log inoculation). *Smith and Graham. 1978. Meat Sci. 2:119-128.*
- Log reductions of *E. coli* from beef sides (6.8-log inoculation) treated with hot water at 3 temperatures and 2 spray times:

Temp	66°C (151°F)	74.2°C (166°F)	83.5°C (182.3°F)
10 sec.	0.91	1.4	2.33
20 sec.	1.1	2.1	3.0

*Davey, K.R. and M G. Smith. 1989. Int. J. Food Sci & Tech. 24:305-316*

- 80°C (176°F) water poured on beef and mutton samples for 10 sec reduced 6.5 logs of *E. coli* by 99%. *Smith & Graham, 1978*
- Sequential water rinses resulted in the following reduction (from 6.8 log initial) of *E. coli*:
  - Pre-visceration wash (tap water at 21-54°C, 345 kPa, 5.6 sec) = 1.1 log reduction
  - Final wash (tap water at 21-54°C, 2069 kPa, 20 sec) = 1.5 log reduction
  - Hot-water rinse (80°C/176°F), 207 kPa for 5.6 sec) = 1.8 log reduction
  - Final wash plus hot-water rinse (above) = 2.3 log reduction*Delmore-Graves, L.R., J. N Sofos, G. R. Schmidt and G. C. Smith. 1998. J. Food Sci. 63(5):890-893*
- After 24 hrs, 51.7°C (125°F) water reduced total aerobic counts by 3.2 logs, compared to 12.8°C (55°F) water reducing total aerobic counts by 2.3 logs. *Kotula et al., 1974, J. An. Sci.39(4):674-679.*
- 80°C water on carcasses leaves a bleached, gray appearance, **which helps determine if entire carcass has been treated**, 7 strains of *E. coli* reduced >1 log with 60°C (140°F) water, for 10 sec, reduced 3 logs with 80°C (176°F) water for 10 sec., roughly the same response with the 20 sec. treatment, with the 80°C water approaching 3.5 log reduction. Used meat pieces, not carcasses. *Smith, M. G. (1992) Epidemiol.Infect. 109:491*

**Lactic Acid**

- A 2% lactic acid solution sprayed on pork carcasses reduced *S. typhimurium* by 2.25 logs (equal to the reduction by 50 ppm chlorine rinse). When a hot water wash (10 sec) was applied after the chlorine rinse, *S. typhimurium* was reduced an additional 2.2 logs. *N. Clayton, 2002. unpublished thesis from U. Kentucky.*
- A water wash (hand-held sprayer, 35C, 1.5 L, 10 psi, 90 sec, followed by a high pressure, 5 L, 250 psi for 5sec, and finally, 400 psi for 4 sec) followed by a 2% lactic acid spray (200 ml, 40 psi, 55°C/131°F) was the most effective antimicrobial treatment compared, with log reductions of *E. coli* 0157:H7 ranging from 3.0 to 4.9, depending upon what carcass surface was sampled; water wash combined with 2% lactic acid was better at reducing *E. coli* 0157:H7 than either trimming or water washing alone, and was significantly better at reducing *E. coli* 0157:H7 than water wash combined with acetic acid. *Hardin, M. D. et al., 1995. J. Food Prot. 58:368-373.*

**Singeing**

- Flame singeing of pork carcasses, for 10 s, reduced *S. typhimurium* population by 2.2-3 logs, and for 20 s by 3.1 logs. Beef carcass singeing research is now being conducted. *N. Clayton, 2002. Unpublished thesis from U. Kentucky.*