Organic Acids

INTERVENTION SUMMARY	
Status	Currently available
Location	Post-slaughter – carcasse or packaging
Intervention type	Surface treatment of carcase, primals, offal
Treatment time	10-30 seconds depending on solution temperature
Regulations	Approved in US, Australia and some approved in EU
Effectiveness	1-3 log reduction
Likely cost	Could cost in the $100,000 to $300,000 range to install a cabinet
Value for money	If there is an existing wash cabinet, capital cost is low and may be good value – estimated cost of solution $1.70 per beef carcass
Plant or process changes	Spray cabinet will be required
Environmental impact	Disposal of chemicals may be an issue
OH&S	Acids are irritants, so careful handling is required Risk of inhalation of irritant Secure storage of the concentrate will be required
Advantages	Applied by spray or immersion Can be used with other treatment/technologies Much literature on efficacy Possible prolonged inhibition of microbial growth
Disadvantages or limitations	When applying by spray, the airborne aerosols - particularly of acetic acid - can have a corrosive effect on equipment surrounding the spray cabinet Concerns about acid-resistant microorganisms

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Organic Acids

Solutions of organic acids (1-3%), such as lactic and acetic acids, are the most frequently used chemical interventions in commercial plants for both beef and lamb dressing. Many other organic acids, however, have been researched either separately or as a mixture for use in chemical washes, including formic, propionic, citric, fumaric, and L-ascorbic acid. The mechanism of action of organic acids on the microbial cell is not completely understood, but it is hypothesised that it is the un-dissociated molecule of the acid that is responsible for the antimicrobial activity.

In the US, organic acids are applied as part of a carcass wash pre-chill and can be applied at levels up to 2.5% (USDA/FSIS, 2004). In addition, lactic acid is approved for use on beef carcasses, sub-primals and trimmings (i.e. pre- and post-chill), offal and variety meats at levels up to 5% at temperatures not exceeding 55°C. The EU authorised the use of lactic acid for decontamination of bovine carcases from February 2013, based on a European Food Safety Authority (EFSA) opinion in 2011 (EFSA, 2011), whereas the USDA has specifically approved lactic acid, acetic acid, and citric acid as antimicrobial agents in the final wash that is applied to livestock carcases after trimming and inspection but before chilling (21 CFR 101.100 (a) (3): FDA, 2003).

There is a lot of variability in the literature in terms of the cited reductions that can be achieved. This is mainly due to differences in the concentrations and types of acids used by different researchers, the method of application, the types of samples tested, and the initial microbial load of samples. Organic acids have been shown to be most effective when applied as a warm (50-55°C) carcass rinse (Acuff, 2005). Unfortunately, the corrosive effect on the equipment seems to increase as the temperature rises. There are conflicting reports as to whether there is greater bacterial inhibition by acetic compared to lactic or citric acid washes. Lactic acid (2%) was shown to reduce *E. coli* O157:H7 on inoculated beef carcase tissue by 3.3 log units, and 2% acetic acid reduced it by 1.6 log units (Ransom *et al.*, 2003). These authors also found that lactic acid and acetic acid treatments on cheekmeat, using spray or immersion, resulted in 1.1 log reductions in total bacteria. The lesser reductions were attributed to the physical structure of cheekmeat, which may protect microbes from the treatments. Organic acids (lactic, acetic, and propionic) have been reported to decrease populations of *E. coli* and other bacteria when sprayed on sheep/goat carcasses or used as a wash (Dubal *et al.*, 2004; Ramirez *et al.*, 2001). Laury *et al*. (2009) reported a reduction in *E. coli* O157:H7 of 1.4 log cfu/100 cm^2 on beef trim after spraying with a commercial lactic and citric acid-based antimicrobial product. Lactic acid was found to be more effective than acetic acid in reducing *E. coli* and *Salmonella* on inoculated samples of beef flank tissue (Arthur *et al.*, 2008). Recent work by Carranza *et al*. (2013) found that an acetic acid spray treatment following water washing was effective at reducing microbial load on beef carcases at a commercial Mexican slaughter house. They reported 0.8-log, 1.54-log and 1.4-log reductions in total plate count, total coliform and faecal coliform counts respectively, when carcasses were sprayed with a 2% acetic acid solution at 10-30 psi for 60 seconds.

In contrast, Gill (2009) concluded that, when looking at the results from three meat processing plants in the US, the apparent effects of the lactic acid spray could be attributed to the washing effect of the treatment rather than any antimicrobial effect of the lactic acid. Greig *et al*. (2012) performed a systematic review-meta-analysis of the published research, looking only at studies that reflected commercial processing conditions. They suggest that whilst the literature does show a greater decrease in the concentration and prevalence of generic *E. coli*, when an acid rinse is incorporated prior to dry chill, compared to dry chill alone, this increased efficacy is relatively small and needs to be evaluated against the increased cost of infrastructure and chemicals.

There is some evidence that organic acids may enhance the shelf life of modified atmosphere packaged product, perhaps because they increase the lag phase of the microorganisms (Podolak *et al.*, 1996). Carpenter *et al*. (2011) claimed that acid washing with acetic acid inhibited the growth of residual *E. coli* O157:H7 for about 2 days, on inoculated beef plate. However, detrimental sensory changes have been reported when beef sub-primals are treated with lactic acid (Smulders and Greer, 1998).

Hot carcass surfaces treated with organic acids often display some discoloration of tissue or fat surfaces. However, as with hot water pasteurisation, this often disappears or becomes less evident after chilling.

In the literature, there is also mention of the possibility for the use of organic acids to alter the microbial ecology of meat plant environments and consequently that of the beef (Acuff, 2005). However, there are concerns associated with using organic acids in that they may select for acid-resistant bacteria that may accelerate rates of product spoilage, increase undesirable effects on product appearance and speed equipment corrosion (Gill, 1998; Stopforth *et al*., 2007).

Approximate costs for organic acid spray in beef/pork processing plants (A$, adapted from Reynolds, 2005)

Organic acid	List price (25kg – Bangicid 88 Excel from IMCD Australia)	Cost per unit (mL)	Cost per litre of solution	Cost per carcass*
Lactic Acid (88% food grade) *2% solution = 23 g + 1 litre* H_2O	$ 173.75.00	0.695¢	16¢	12.8¢ (pig) 25.6¢ (beef)

* Eight litres of 2% lactic acid will treat approximately 10 pigs or 5 beef carcasses.

Proponent/Supplier Information

Wash cabinets may be installed by a number of companies such as CHAD:

CHAD Company

19950 West 161st Street

Olathe, KS 66062

United States

Ph: +1 913 764 0321

Fax: +1 913 764 0779

Website: http://www.chadcompany.com/

There are many food-grade acid suppliers in Australia. One larger company is IMCD Australia.

IMCD Australia

1st Floor, 372 Wellington Rd

Mulgrave, VIC 3170.

Ph: 03 8544 3100

Fax. 03 8544 3299

Website: http://www.imcd.com.au/

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