Utilization of spray wash with organic acids (peroxyacetic acid and lactic acid) and chlorinated wash in combination, utilizing direct application methods, for pathogen reduction on pork and beef carcasses in small and very small meat processing plants (revised 8/24/2005)

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Introduction:
The efficacy of organic acids to reduce total bacterial loads and pathogens has been well demonstrated over the past 30 years (Reynolds, 1973; Dickson and Anderson, 1992; Handin *et al*., 1995). Numerous methods of applying antimicrobial solutions to beef and pork carcasses have been developed, but most are too expensive for use in small and very small meat processing plants.

This study was designed to evaluate the effectiveness of acid spray wash with peroxyacetic acid (180-200 ppm) or lactic acid (2% to 2.5%) on beef and pork carcasses using a hand sprayer with fan jet nozzle at 20-30 psi. The number of carcasses tested varied with each of the three trials due to the availability of animals. One phase tested hot pork carcasses destined for immediate processing prior to chilling. There is no previous research information on decontaminating hot pork carcasses utilized immediately to produce fresh pork sausage.

Objective:
To develop methods of application of organic acids and other antimicrobial agents for use in small and every small processing plants that will effectively contribute to the reduction of pathogens on pork and beef carcasses. Special attention will be given to application to hot hog carcasses to be utilized prior to chilling.

Materials & Methods
Spray equipment
2-4 gallon, hand-pump sprayers with fan nozzle, cost less than $100 each.

Chemicals used
Lactic acid (88% Food Grade, Fisher Scientific); peroxyacetic acid (180-200 ppm, Inspexx 100, Ecolab). Strength of the wash solutions were tested with a dissolved solids test meter.

Lactic acid 2% solution was formulated by mixing five ounces of lactic acid into two gallons of water. The peroxyacetic acid solution was mixed by adding 20 ml to 5 gallons of water.

Pork carcasses
Hot pork carcasses were swab tested for total aerobic plate count, *E.coli*, *Salmonella*, and coliform contamination. Hot carcasses from market hogs were sprayed subsequent to the final chlorine (50ppm) wash. These carcasses were to be immediately processed into fresh pork sausage.

Beef carcasses
Beef carcasses were first swabbed hot before spraying for total aerobic plate count, *E. coli*, *Salmonella* and coliform contamination. Carcasses were sprayed and chilled, then swabbed for total aerobic plate count, E. coli, Salmonella and coliform contamination.

Treatments

Pork carcass spray washing:

Hot pork carcasses from market hogs were sprayed subsequent to the final chlorine wash (50ppm). The carcasses were sprayed using hand pump sprayers with a jet fan nozzle at 20-30 psi, using 2% lactic acid or 180-200 ppm peroxyacetic acid. The number of carcasses varied in each of the three trials due to the availability of animals. Carcasses were sampled on one side prior to spraying as a control. Carcasses were acid sprayed and allowed to drain for five minutes prior to sampling the opposite side. Sampling procedures were in accordance with USDA *E. coli* sampling.

Beef carcass spray washing:

Hot beef carcasses were washed and rinsed with a 40 ppm chlorine solution. After washing, the hot carcasses were sampled in accordance with USDA sampling procedures for *E. coli.* This served as the control.

The carcasses were then sprayed with 2.0% to 2.5% solution of lactic acid or 180-200 ppm peroxyacetic acid. The spraying was accomplished using hand pump sprayers with a jet fan nozzle at 20-30 psi.

One group of beef carcasses was treated with a hot water (180 F) wash, but this step was discontinued after the first trial because it did not reduce *Salmonella* positives.

Results

Pork:

The peroxyacetic wash showed a .3 to 1.0 log 10 reduction in aerobic plate counts, and had a 50% reduction in the number of positive *Salmonella* samples. *E. coli* and coliform counts were lower than on the untreated control samples.

Lactic acid wash (2%) gave a 0 to 1.2 log 10 reduction in aerobic plate counts and a 66% reduction in the number of positive *Salmonella* samples. Both acids were effective in reducing the total aerobic plate count, *E. coli* and coliform counts to less than 10 CFU/ml and were effective in killing enteric organisms. Lactic acid was easier to handle, did not require refrigerated storage and had a residual effect on the microbial load, on especially enteric organisms, as shown by the data.

Beef:

Peroxyacetic acid was effective in reducing the aerobic plate count in two of the three trials by 1 log10. One trial was chilled using a chlorine spray during chilling and the aerobic plate count increased by 1.1 log10 CFU/ml. No positive *Salmonella* samples were found in any of the peroxyacetic acid treated carcasses in any trial. *E. coli* were for the most part below 10 CFU/ml for all samples.

Lactic acid treated carcasses showed a 0.5 to 0.7 log 10 reduction in aerobic plate counts, but a 1.8 log 10 increase in the spray chill carcasses. No positive *Salmonella* samples were found in any of the treated samples and *E. coli* was maintained below 10 CFU/ml in the sampled carcasses.

A post-chill peroxyacetic acid wash was used on the carcasses after chilling in Trial # 1 and resulted in two positives for *Salmonella*, probably due to the extra handling of the carcasses.

Recommendations for use:

A 2.0% lactic acid solution is recommended for hot pork carcasses that are to be used immediately in the production of pork sausage. One gallon of solution should cover 10 hog carcasses effectively.

Use either 2.0% to 2.5% solution of lactic acid or 180-200 ppm peroxyacetic acid in conjunction with a 40-50 ppm chlorine wash on beef carcasses. Two gallons of solution should cover 20 beef carcasses effectively.

A 2-4 gallon, hand-pump sprayer with a jet fan nozzle at 20-30 psi at a cost less than $100.

Lactic acid can be purchased in bulk from most commercial chemical distributors or in a smaller quantity from Fisher Scientific. Peroxyacetic acid is also available from chemical distributors; one brand, Inspexx 100, can be purchased from Ecolab.

Proper handling and storage of the chemicals is very important. Peroxyacetic acid requires refrigerated storage; MSDS sheets from the supplier should be placed with the HACCP plan; copies also should be displayed in the chemical storage area for quick reference.

Strength of the wash solutions should be tested with a dissolved solids test meter.

Benefits to Small/Very Small Plants
For beef, peroxyacetic acid was more effective, but lactic acid has additional residual effect. For pork, lactic acid spray wash was most effective in reducing the TPC, *Salmonella* and *E. coli* positives when preceded by a chlorine (40-50ppm) final wash prior to chilling. Thus, maintaining effective free chlorine levels in the final wash water is very important.

Approximate Costs for Organic Acid Spray in Beef/Pork Processing Plants

Organic Acid	*List Price (50 gal)*	*Cost per Unit*	*Cost per Gal. of Solution*	*Cost per Carcass**
Lactic Acid (88% food grade) *2% solution = 5 oz + 2 gal H_2O*	$ 800.00	$ 0.1250 (oz)	$ 0.64	$ 0.064 (hog) $0.128 (beef)
Peroxyacetic Acid *200 ppm = 8 mL + 2 gal H_2O*	$ 1,336.10	$ 0.0071 (mL)	$ 0.0282	$ 0.00282 (hog) $ 0.00565 (beef)

* One gallon of 2% lactic acid or peroxyacetic acid (180-200 ppm) will treat approximately 10 hogs or 5 beef carcasses.

Revised summary emailed to Howard Early 8-3-05 ebm
Table revised 8-24-05 ebm

Entire report with procedure steps emailed to Howard Early & Dr. Murthy 8-26-05

ADDED 8-24-05 per request of Dr. Murthy

Utilization of spray wash with organic acids (peroxyacetic acid and lactic acid) and chlorinated wash in combination, utilizing direct application methods, for pathogen reduction on pork and beef carcasses in small and very small meat processing plants (revised 8/24/2005)

Steps in applying acids using spray method to reduce pathogens

Step 1

A. Purchase a two to four-gallon stainless steel or plastic pump-up hand sprayer which can be pumped up to 20-30 psi. Use with a fan nozzle to apply the acid spray solution.

B. Purchase food grade Lactic Acid (88%) and/or Peroxyacetic Acid (such as Ecolab's *Inspexx 100*). Note that peroxyacetic acid must be stored in a well-ventilated, cool area and safety precautions must be observed when handling it.

Step 2

A. A solution of the chosen organic acid may be mixed directly in the sprayer. Be sure to follow the safety precautions given on the MSDS sheet when handling the chemicals.
Accuracy in measuring the acid concentrate is important, so measure the acid using a volumetric pipette sufficient to make TWO gallons of solution. Measure warm water (120°F) into the sprayer, then add the measured acid concentrate, close the sprayer and shake solution to mix thoroughly. Pump sprayer according to manufacturer's instructions to obtain 20-30 psi pressure.

B. For a 2% LACTIC ACID solution, measure five ounces (5.12 oz or 151.4 mL) of 88% Lactic Acid and mix into two gallons (7.5 l) of warm water (120°F) in the sprayer. Close the sprayer and shake to mix thoroughly. Pump sprayer to 20-30 psi.

C. For PEROXYACETIC ACID 180-200 ppm solution, put on protective gloves, apron and eyewear before opening the chemical container to prevent skin contact or splashing (see MSDS sheet for other safety precautions). In a well-ventilated area, measure two gallons (7.5 l) of warm water (120°F) into sprayer. Carefully measure 8-10 mL of peroxyacetic acid using a pipette and put into the sprayer. Return remaining peroxyacetic acid concentrate to locked chemical storage area. Close sprayer and shake the solution to insure thorough mixing. Pump up sprayer to 20-30 psi pressure.

Step 3
Following the final carcass wash using a 50 ppm chlorine rinse, spray the hot carcass (pork or beef) with the acid spray solution (either lactic or peroxyacetic), thoroughly wetting the surface to create some drip.

Step 4
After weighing, push the carcasses into the cooler for chilling.

Note: Prior to spraying carcasses with acid wash, insure that the final rinse water contains ≤ 50 ppm chlorine. This assists in controlling microbial levels.