ACIDIFIED SODIUM CHLORITE: A NOVEL PROCESSING AID FOR USE AS AN ANTI-MICROBIAL ON RED MEAT CARCASSES

Kemp, G. Kere, Warf, C. Cayce, Hawk, Chris N.
Alcide Corporation, P.O. Box, Redmond, Washington 98040, USA. E-mail: kkemp@alcide.com

Background

Numerous methods for decontaminating beef carcasses and/or trim have been investigated. Steam pasteurization was shown to be effective in reducing aerobic plate counts as well as generic *Escherichia coli* (Nutsch et al., 1998). Similarly, steam vacuuming treatments reduce indicator organisms by as much as 3.0 log cycles (Castillo et al., 1999) and have been demonstrated effective against *E. coli* O157:H7 (Dorsa et al., 1996). Hot water alone (Castillo et al., 1998; Kang et al, 2001) and hot water in conjunction with hot air (Kang et al., 2001) were studied for decontaminating beef. Previous studies examined the use of organic acids, such as lactic acid and/or acetic acid for the sanitization of beef carcasses and beef trim (Kang et al., 2001; Cutter and Rivera-Betancourt, 2000; Cutter et al., 2000; Anon, 1996). The effectiveness of these organic acids was shown to be associated with carcass temperature (Cutter and Rivera-Betancourt, 2000). Chemical sanitizers such as chlorine (Siragusa et al., 1998; Zhao et al., 2001), Tween 20 with lactic acid (Calicioglu et al., 2002), cetylpyridinium chloride (Cutter et al., 2000), trisodium phosphate (Cutter and Rivera-Betancourt, 2000; Whyte et al., 2001), hydrogen peroxide and chlorhexidine (Delazari et al., 1998), and acidified sodium chlorite (ASC) (Castillo et al., 1999; Kemp et al., 2000) have also been studied. When applied following water wash, ASC has been shown to be effective in reducing the levels of *E. coli* O157:H7 and *Salmonella Typhimurium* on beef carcass parts by 4.5 to 4.6 log cycles when activated by citric acid (Castillo et al., 1999). Kemp et al., 2000 also studied the efficacy of ASC dip treatments for the sanitation of broiler carcasses, finding ASC provided a 99.4 to 99.6% reduction of *E. coli* and 86.1 to 98.5% reduction of total coliforms.

ASC is an oxidative biocidal process generated at time of use from the combination of sodium chlorite and a weak acid. Typically citric acid is used as the acidulant to form ASC due to its generally recognized as safe (GRAS) status. ASC is approved for use as a Processing Aid in the United States, Canada and in Chile. It is applied as either a spray or an immersion on poultry and red meat carcasses and carcass parts, on fruits and vegetables and on seafood. While approved for a maximum application rate of 1,200 parts per million sodium chlorite, it is more typically used in commercial settings at a concentration of 1,000 ppm and a pH of 2.5. An application seeking approval for use of this processing aid in Brazil is currently (as of January 2003) under review by ANVISA (Agencia Nacional de Vigilancia Sanitaria).

Objectives

The focus of the present four studies was to: i) evaluate different spray times/spray volumes for the SANOVA® system for spraying whole beef carcasses in typical commercial slaughter-houses with citric acid activated-ASC (C-ASC); ii) conduct comparisons of the performance of C-ASC versus lactic acid (LA) treatments of whole or eviscerated carcasses at use-rates typical of those utilized in commercial applications within the United States of America; iii) evaluate the added benefits of C-ASC or LA treatments on steam pasteurized carcasses.

Methods

Testing locations. All treatments and samplings were performed at federally inspected beef slaughter plants in the United States of America. Samples for microbial analysis were prepared and shipped overnight to an independent microbiological laboratory using methods described by Karr et al., 1996.

Experimental design. Whole, freshly slaughtered intact or eviscerated carcasses were subjected to various treatments of 1000 ppm C-ASC (0.10% sodium chlorite/ 0.60% citric acid). In the first test, four treatments were studied which were combinations of spray volume (1 or 2 gallons per side) and application time (10 or 15 seconds), were evaluated on hot freshly eviscerated carcasses. In the remaining tests, a set volume and exposure time for C-ASC of 1 gallon per side and 15 seconds was evaluated. Comparisons were also made with 2% LA heated to 55°C when applied at typical commercial use rates. All treatments were conducted inside a purpose designed stainless steel spray cabinet, which was positioned on the evisceration line between the final carcass wash station and the rail leading to the hot-box area. The spray cabinet was fitted with hinged doors on either end to provide an enclosed environment during spraying. A fan ducted to the top of the cabinet drew a negative air pressure inside the cabinet and exhausted to the outside of the building.

Microbiological. Sampling was performed using sterile sponge kits (International BioProducts (IBP) # BP-237-SPG) and 100 cm^2 sterile templates (IBP # USDA-100). For each carcass to be sampled, a sterile 100 cm^2 template was placed on the lower neck flap meat surface. The dehydrated sponge was moistened with 10 mL of sterile 1.0% buffered peptone water (BPW) (IBP # USDA-25PBW) to which 1% sodium thiosulfate (Fisher Chemicals, S446-500) had been added. The moistened sponge was then used to swab the 100 cm^2 area. A minimum of 3 strokes in each of three separate directions was employed, with the sponge flipped over midway to maximize the contact area. After sampling was complete, the sponge was returned to its individual sterile bag and the additional 15 mL of BPW was added. The bag was sealed, labeled, and packed on gel-ice for shipment to the test laboratory. Upon receipt, samples were checked for proper temperature and package integrity. Aerobic plate count (APC) was determined using standard methods (AOAC Official Method 966.23). *E. coli* counts were determined by use of Petrifilm™ (3M, St. Paul, MN) (AOAC Official Method 991.14).

Statistical Analysis. All counts were converted to $\log_{10}$ values and averaged for each treatment leg to provide a geometric mean, which was then used for all statistical analysis. Treatments of significant difference were identified using the Duncan's multiple range test.

Results and Discussion

For *E. coli*, all of the pre-chill microbial counts were extremely low throughout all of the studies with the majority of the samples being recorded as zero. Similarly all of the post-treatment counts were effectively zero for *E. coli*. As a result, evaluations of microbial reduction performance for the C-ASC treatments as well as for the LA treatments were based on the impact of treatment on total aerobic counts. In the first test the results for total aerobic count reduction for the 2-gallon per side application rate of C-ASC were 1.16 $\log_{10}$ and 1.10 $\log_{10}$ for the

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10-second and 15-second application times respectively. Both these results were significantly better than those achieved for the 1gallon/10 second application (0.82 $\log_{10}$) and the 1-gallon/15 second application (0.65 $\log_{10}$). Air chilling of carcasses appeared to provide an additional 0.5 $\log_{10}$ reduction regardless of treatment.

In the second commercial plant test on eviscerated carcasses, C-ASC treatment for 15 seconds at a rate of 1 gallon per side of eviscerated carcasses generated a reduction of 1.05 $\log_{10}$ total aerobic count. In comparison heated 2% LA (5 seconds, 0.5 gallon per side) generated a reduction of just 0.35 $\log_{10}$. In the third test on pre-eviscerated carcasses, the C-ASC treatment generated a reduction of 2.40 $\log_{10}$ while LA treatment at normal commercial application rates generated a reduction of 0.25 $\log_{10}$. In the final test on post-evisceration carcasses, steam pasteurization was found to actually have caused a net increase in total aerobic counts of almost 1 log (-0.99 $\log_{10}$ reduction). When steam pasteurization was combined with a post-pasteurization spray treatment with LA (5 seconds, 0.5 gallon per side), the performance of the total system was found to be no better than steam pasteurization by itself (-0.85 $\log_{10}$ reduction). In comparison, a combination of steam pasteurization and C-ASC (15 seconds, 0.5 gallon per side) generated a net 0.56 $\log_{10}$ reduction in the total aerobic population.

Conclusions

In this series of tests, C-ASC treatment of hot, whole or freshly eviscerated beef carcasses was found to significantly impact surface microbial populations resulting in reductions of total aerobic counts ranging from 0.64 to 2.40 $\log_{10}$. While *E. coli* and total coliform counts were too low to be evaluated in these commercial plant tests, previous work by Castillo et al., (1999) has shown that similar application rates for C-ASC treatments resulted in greater than 2 $\log_{10}$ reductions for *E. coli* and *Salmonella Typhimurium*. In comparison, LA when applied at typical commercial plant use-rates, consistently performed poorly. As applied in these tests, C-ASC demonstrated an ability to provide a highly efficient yet cost-effective anti-microbial intervention step for beef carcasses just prior to the chill process. No adverse changes of color, texture or quality were noted on any of the carcasses post-treatment. Efficient use of this novel Processing Aid during the evisceration process is expected to offer the Brazilian red meat processing industry an ability to significantly impact the safety and quality of its beef and other red meats.

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