

**ANTIBACTERIAL EFFECTIVENESS OF A SECOND  
GENERATION STEAM PASTEURIZATION™ SYSTEM  
FOR BEEF CARCASS DECONTAMINATION**

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**Summary**

The original commercial Steam Pasteurization™ System (SPS 400) involved a sealable moving car by which carcass sides were carried through the steam chamber at standard line speeds. A second generation “static chamber” system (SPS 400-SC) eliminates the mechanical moving car and has been installed in a large beef slaughter facility. We collected data to verify SPS 400-SC’s effectiveness at chamber temperatures from 185 to 205EF in a batch process mode (only test carcasses passing through the unit at variable intervals to facilitate collection of research samples) and at 190EF with the system running continuously. Tissue samples were obtained from different carcass anatomical locations to evaluate the uniformity of thermal treatment. Batch-type steam treatment at 185 and 190EF did not consistently produce significant bacterial reductions on the five anatomical locations sampled. Batch processing at 195, 200, and 205EF provided increasingly greater total bacterial reductions, ranging from 1.0 to 2.0 log colony forming units (CFU)/cm<sup>2</sup>. Under continuous operation at 190EF, typical of commercial operation, total bacterial reductions at the carcass midline averaged 1.6 log CFU/cm<sup>2</sup>. The new SPS design is substantially simplified in terms of moving components and should offer highly efficient operation and less mechanical upkeep, extremely important in Hazard Analysis Critical Control Point (HACCP) programs, which require assurance of virtually 100% system operation. The new SPS 400-SC design will provide beef processors a very effective and reliable means of assuring that microbiologically clean carcasses enter the holding cooler, thus substantially reducing the risk of pathogenic contamination.

(Key Words: Steam Pasteurization, Beef Carcass Decontamination, Antibacterial.)

**Introduction**

Recent widely publicized outbreaks of *Escherichia coli* O157:H7 and other pathogens in the U.S. meat supply have forced researchers, regulators, and the meat industry to examine methods to reduce foodborne pathogens in meat products. Focus has been on developing intervention technologies to reduce bacterial contamination on carcasses prior to chilling. One intervention technology, fast becoming an industry standard, is Steam Pasteurization™. The original commercial-scale unit, designed by Frigoscandia Food Processing Systems (Redmond, WA) for inline processing, consisted of a stainless steel cabinet enclosing an overhead rail that housed a moving internal compartment (“car”), into which carcass sides were collected and exposed to steam. A new generation of that unit eliminates the internal moving compartment. This new design is intended to increase line efficiency, and by simplifying mechanical and electrical components, reduce the potential for breakdown.

We conducted studies to verify that the new static chamber prototype (SPS 400-SC) was effective in reducing bacteria on beef carcass sides. In addition, we compared anatomical locations in terms of bacterial contamination before and after steam treatment. We also compared batch-type processing at several temperatures and a continuous pasteurization at 190EF.

## Experimental Procedures

In batch-type studies, the SPS 400-SC unit was adjusted and held at the target chamber temperature. Randomly selected carcass sides (4-6) were railed onto the approach rail and held at the entrance of the unit for collection of before-pasteurization (B) tissue samples. The carcasses then were allowed to pass through the SPS 400-SC unit at typical line speed and were released into the chilling cooler on a dedicated sampling rail where after-pasteurization samples (A) were collected. In the 190EF continuous test, production line carcass sides passed through the SPS 400-SC unit at operational line speed. Random sides were tagged for identification as they approached the unit. An anatomical midline sample (B) was excised, the carcasses proceeded through the SPS 400-SC unit, and an after pasteurization sample (A) was taken immediately adjacent to the previous excision site. For the 185EF batch-type test, 30 carcasses were evaluated. For all other tests, 20 carcasses were tested.

Carcass tissue samples (21 cm<sup>2</sup> of surface area) were excised at five anatomical locations [neck, midline, inside round exterior, rope muscle (sternoman dibularis), and inside round cut muscle surface], using a sterile coring device, scalpel, and forceps. Samples were placed in plastic bags, transferred to an insulated cooler with cold packs, and shipped overnight to the analytical laboratory. Adjacent samples were collected from the same carcass immediately prior to entering the SPS unit and within 5 min of exiting the chamber.

All tissue samples were analyzed on the day of receipt. Total aerobic bacteria, coliform, generic *E. coli*, and *Enterobacteriaceae* counts were determined on 3M Petrifilm plates specific for each population. Mean log<sub>10</sub> CFU/cm<sup>2</sup> were calculated, and statistical analyses were performed to determine differences between (B) and (A)

counts, reductions at different anatomical sites, and batch processing at various temperatures vs. 190EF continuous steam processing.

## Results and Discussion

Batch type processing at 185EF provided only minimal bacterial reductions at all anatomical sites. The midline of carcasses were substantially more contaminated than other locations. The 185EF batch-type thermal treatment was not equivalent to the same temperature setting in our earlier studies, as evidenced by less lean surface discoloration.

We compared batch-processing temperatures of 190, 195, 200, and 205EF and sampled neck, midline, and inside round sites. Total bacterial reductions increased as temperatures increased to 200EF. At 195EF, total reductions (all anatomical sites combined) were 1.4 log<sub>10</sub> CFU/cm<sup>2</sup>. These reductions increased to 1.6 log<sub>10</sub> at 200EF. A 1 log reduction is 90%, and 2 log represents 99% reduction. Table 1 shows significant *Enterobacteriaceae* reductions at all temperatures except 185EF. Coliform and *E. coli* results were very similar (data not presented).

Thermal treatment effects were compared between the SPS 400-SC operating in a batch vs continuous mode at 190EF. The batch-type carcasses exhibited only slight graying of lean and cut surfaces. Continuous process carcass lean appeared more extensively gray, more typical of earlier SPS verification studies with original design. This color reverts to a natural red color after a short chilling period. Total aerobic bacterial reductions on continuously treated carcasses were superior to those on batch processed carcasses at 190EF (1.6 vs .7 log<sub>10</sub> CFU/cm<sup>2</sup>, respectively). No continuously treated carcass was found positive for any of the Gram negative bacterial groups evaluated (Table 1).

**Table 1. Effectiveness of SPS 400-SC Steam Pasteurization in Reducing *Enterobacteriaceae* Bacteria Populations on Beef Carcasses**

| Anatomical Site       | Positives/<br>Ranges        | Carcass <i>Enterobacteriaceae</i> Distributions (CFU/cm <sup>2</sup> ) |                    |                    |                    |                    | 190EF<br>CON     |
|-----------------------|-----------------------------|--|--------------------|--------------------|--------------------|--------------------|------------------|
|                       |                             | 185EF <sup>c</sup>   | 190EF <sup>d</sup> | 195EF <sup>d</sup> | 200EF <sup>d</sup> | 205EF <sup>d</sup> |                  |
| Neck                  | B <sup>+</sup> <sup>a</sup> | 11   | 3                  | 4                  | 13                 | 7                  |                  |
| Neck                  | A <sup>+</sup> <sup>a</sup> | 4  | 0                  | 2                  | 0                  | 7                  |                  |
| Neck                  | B <sup>*</sup> <sup>b</sup> | 181.6  | .8                 | 5                  | 42.9               | 6.6                |                  |
| Neck                  | A <sup>*</sup> <sup>b</sup> | 42.1   | 0.4 <sup>f</sup>   | 0.8                | 0.4 <sup>f</sup>   | .8                 |                  |
| Midline               | B <sup>+</sup>              | 15   | 15                 | 9                  | 12                 | 9                  | 8                |
| Midline               | A <sup>+</sup>              | 13   | 3                  | 1                  | 3                  | 2                  | 0                |
| Midline               | B <sup>*</sup>              | 35.5   | 18.2               | 42.9               | 85.9               | 39.6               | 19               |
| Midline               | A <sup>*</sup>              | 150.2  | 1.7                | 0.8                | 53.7               | 14.9               | 0.4 <sup>f</sup> |
| Inside Round          | B <sup>+</sup>              | 6  | 7                  | 10                 | 6                  | 5                  |                  |
| Inside Round          | A <sup>+</sup>              | 2  | 1                  | 1                  | 1                  | 1                  |                  |
| Inside Round          | B <sup>*</sup>              | 9.1  | 40.5               | 107.3              | 84.2               | 26.4               |                  |
| Inside Round          | A <sup>*</sup>              | 379.7  | 0.8                | 0.4 <sup>f</sup>   | 9.9                | .8                 |                  |
| All sites<br>combined | B <sup>+</sup>              | 11   | 8                  | 8                  | 10                 | 7                  | 8                |
|                       | A <sup>+</sup>              | 6  | 1                  | 1                  | 1                  | 2                  | 0                |
|                       | B <sup>*</sup>              | 75.4   | 19.8               | 51.7               | 71                 | 24.2               | 19               |
|                       | A <sup>*</sup>              | 190.7  | 0.8                | 1.9                | 21.2               | 5.5                | 0.4 <sup>f</sup> |

<sup>a</sup>B<sup>+</sup> and A<sup>+</sup> = number of carcasses testing positive before and after SPS 400-SC.

<sup>b</sup>B<sup>\*</sup> and A<sup>\*</sup> = highest observed count (CFU/cm<sup>2</sup>) before and after SPS 400-SC.

<sup>c</sup>N = 30 carcass sides per anatomical site, 90 total observations across three sites.

<sup>d</sup>N = 20 carcass sides per anatomical site, 60 total observations across three sites.

<sup>e</sup>N = 20 carcass sides per anatomical site, 20 total observations at one site (midline); carcass sides were pasteurized continuously.

<sup>f</sup>Half the detection limit was used in place of a value of 0.