Microbiological Profiles of Hog Carcasses During Processing

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Summary: The microbiological profiles of hog carcasses were determined in modern commercial slaughter establishments, representative of both scalding and skinning operations. The populations of mesophilic aerobic bacteria, coliforms, and *Escherichia coli* Biotype I were determined were determined, in addition to the incidence of salmonellae. Approximately 50% of the hog carcasses at the bleeding stage were positive for salmonellae, but no salmonellae positive carcasses were found in the coolers.

Introduction:

The current interest in food safety by both the Industry and Regulatory agencies has focused attention on animal production and processing procedures. The HACCP system of quality management has been mandated by USDA-FSIS to reduce the level of microbial contamination on animal carcasses. To evaluate the success of HACCP in the processing plants, USDA-FSIS has also initiated finished product testing as a monitoring step in the processing plants. The sampling program for Escherichia coli Biotype I and salmonellae, which will begin in January 1997, samples carcasses from a single location after chilling. However, this provides no insight into the pattern of contamination, or de-contamination, which occurs during normal pork slaughter and dressing procedures. This

information is crucial to the understanding of critical operations and identification of critical control points within the slaughter establishments.

Materials and Methods:

Processing Establishments: Two large commercial pork processing establishments participated in this study. The first establishment ("scald") follows a typical hog slaughter process which included scalding, and processes approximately 1100 animals/hour. This establishment has an organic acid rinse immediately following the final carcass rinse. The second establishment ("skinning") skins the hog carcasses rather than employing a scald process, and processes approximately 1000 animals/ hour. The skinning establishment has a pre-evisceration organic acid rinse (after skinning and prior to evisceration), as well as an organic acid rinse after the final carcass wash. Both establishments employ a "deep chill" system to rapidly (< 2 hours) cool the carcasses to approximately 3 ^{o}C.

Sampling: Carcasses were sample after bleeding, after scalding (or skinning), after evisceration, before chilling, and after a minimum of 12 hours of chilling. The carcasses were sampled according to the procedures outlined by USDA-FSIS. Briefly, 100 cm^2 was swabbed using the same swab at each of three locations per carcass: the belly near the midline, the ham and the skin from the jowl. The swabs consisted of sterile sponges (Nasco, Ft. Atkinson, WI) hydrated with 20 ml sterile buffered peptone water (Oxoid, Ogdensburg, NY). Fifteen carcasses were randomly selected and sampled on each of three non-consecutive days in the scalding establishment. However, to determine the variation between sampling locations, the three different carcass sample locations on each of 5 carcasses in the scald establishment were sampled each day and were analyzed

independently; that is, the belly, ham and jowls were swabbed separately and analyzed as three separate samples. Twenty carcasses were randomly selected and sampled on each of three non-consecutive days in the skinning establishment.

Microbiological Analysis: The carcass swabs were analyzed for mesophilic aerobic bacteria, coliforms, *Escherichia coli* Biotype I and salmonellae at a contract testing laboratory. The mesophilic aerobic bacteria were enumerated on tryptic soy agar using a spiral plater and incubated at 35°C for 48 hours. Total coliforms and generic *Escherichia coli* were enumerated using the PetriFilm *E. coli* plates (3-M, Minneapolis, MN). The salmonella assay was conducted with a 24 hr non-selective enrichment in buffered peptone water, followed by selective enrichment. Presumptive positive salmonellae were determined using the Organon Teknika Salmonella ELISA method (Organon Teknika, Durham, NC). Presumptive positive samples were streaked from the selective enrichment for isolation on XLD agar (Difco, Detroit MI), and colonies exhibiting typical reactions for salmonellae were further evaluated using triple sugar iron agar and lysine iron agar slants (Difco). Cultures which demonstrated typical reactions in these tests were confirmed a more extensive set of biochemical reactions (BBL Crystal System, Enteric/Non-fermenter, Becton Dickinson Microbiology Systems, Cockeysville MD).

Results and Discussion:

The scald process was found to result in the most significant reduction in coliforms, and *Escherichia coli* Biotype I (Figure 1). The populations were reduced by approximately 1 $\log_{10}$ cycle at the scalding operation, and then declined further during the process. The carcasses sampled after scalding were sampled as the carcasses exited the scald tank, so it

is conceivable that there was some additional death of the organisms to heat injury. A more likely explanation is that the other processes, especially polishing and singeing, contributed to the overall decline in the populations during the process. The levels of Escherichia coli Biotype I in the coolers were generally below the minimum detection limit for the method employed. That is, most of the samples would have resulted in a "< 0.08 colony forming unit/cm^2" result, which would have put them in compliance with the current USDA-FSIS sampling guidelines. There was relatively little change in the mesophilic aerobic populations at any point in the process. It is likely that a significant percentage of this population on scalded hogs consists of thermoduric bacteria and spore formers, which would survive the scalding process. If this hypothesis is true, this population would in fact be stable throughout the processing operation.

The incidence of salmonellae on the incoming carcasses, as determined during the bleeding operation, was approximately 45% positive (Figure 2). Scalding apparently was quite effective in eliminating these organisms, in that only one other salmonellae positive carcasses was recovered at any point in the process out of 180 carcasses sampled. No salmonellae were recovered on the finished carcasses in the coolers. The initial level of salmonellae on the carcasses is significant, in that any processing operation which starts with approximately 50% of its' incoming raw materials contaminated has a certain risk associated with that process.

The skinning process was also found to result in the most significant reduction in coliforms and *Escherichia coli* Biotype I (Figure 3). The populations were reduced by approximately 1 $\log_{10}$ cycle at the skinning operation, with a slight decline further during the process. As with the scalding operation, most of the carcasses sampled in the coolers

would have resulted in "< 0.08 colony forming unit/cm^2", which would have put them in compliance with the current USDA-FSIS sampling guidelines. The skinning operation is radically different from the scalding operation, in the hide is physically removed from the carcass, much like a beef slaughter process. Since the muscle tissues of the carcasses are theoretically sterile prior to skin removal, the likely source of the contamination on the carcasses after skinning is from the skinning operation itself. As previously noted, this establishment applies a pre-evisceration wash and organic acid rinse prior to evisceration, which undoubtedly contributes to the further reduction seen in coliform and *E. coli* populations after this intervention treatment.

population would in fact be stable throughout the processing operation.

The incidence of salmonellae on the incoming carcasses, as determined during the bleeding operation, was approximately 60% positive (Figure 4). The removal of the skin greatly reduced this incidence to less than 5 % after skinning, and the incidence remained at this approximate level until final chilling. No positive salmonellae carcasses were found on the finished carcasses in the coolers. In all, nine positive carcasses were found out of 240 carcasses sampled after skinning, for an average incidence of 4%. As with the populations of the other bacteria, if the muscle tissues of the carcasses are theoretically sterile prior to skin removal, the likely source of the contamination on the carcasses after skinning is from the processing operation itself. The initial level of salmonellae on the carcasses is significant, in that the risk associated with processing groups of carcasses in which approximately every other carcass is positive for salmonellae is high.

Figure 1. Average populations of mesophilic aerobic bacteria, coliforms, and *Escherichia coli* Biotype I on hog carcasses at five locations in a slaughter establishment using the scald process.

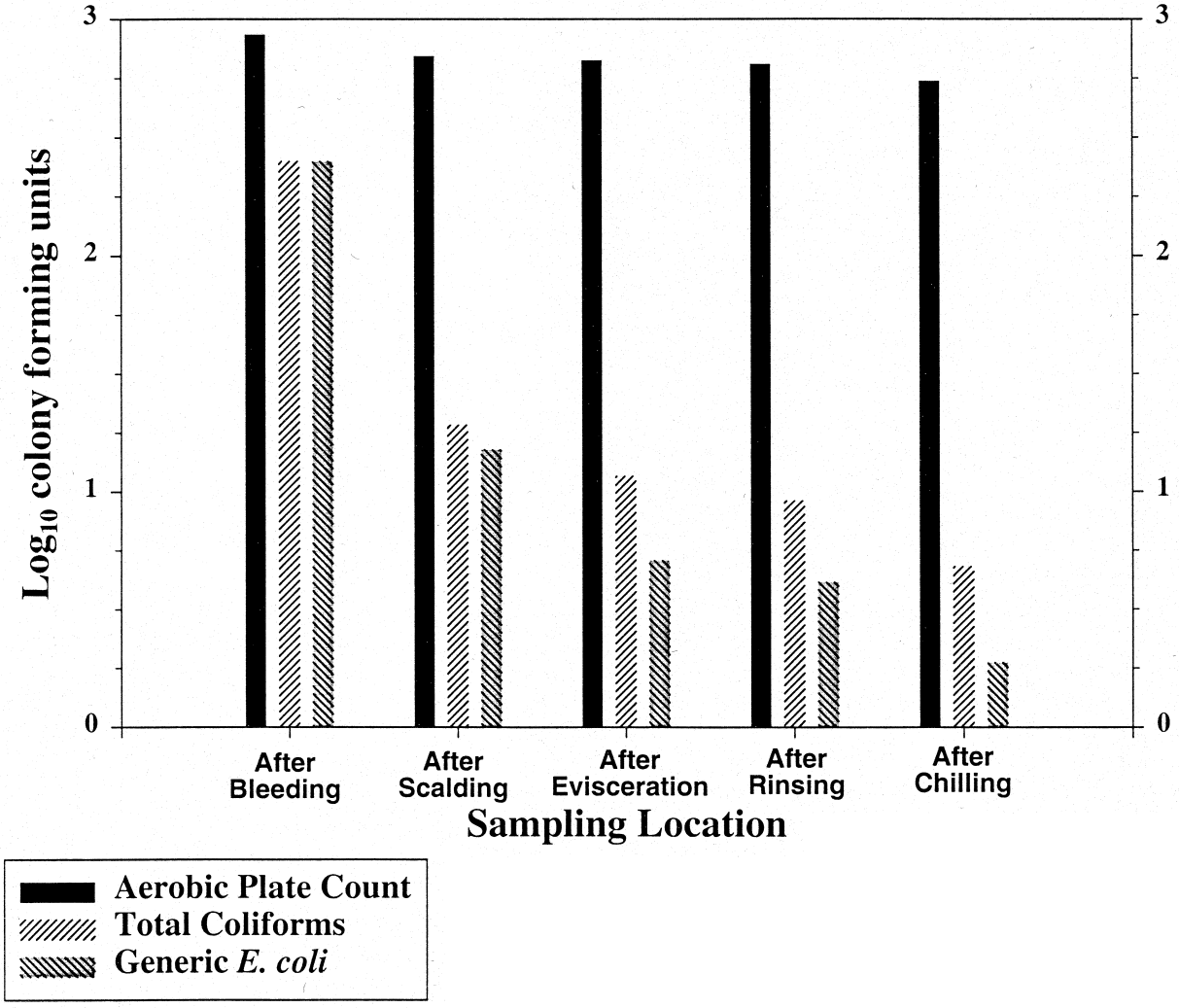

Figure 2. Incidence of salmonellae on hog carcasses at five locations in a slaughter establishment using the scalding process.

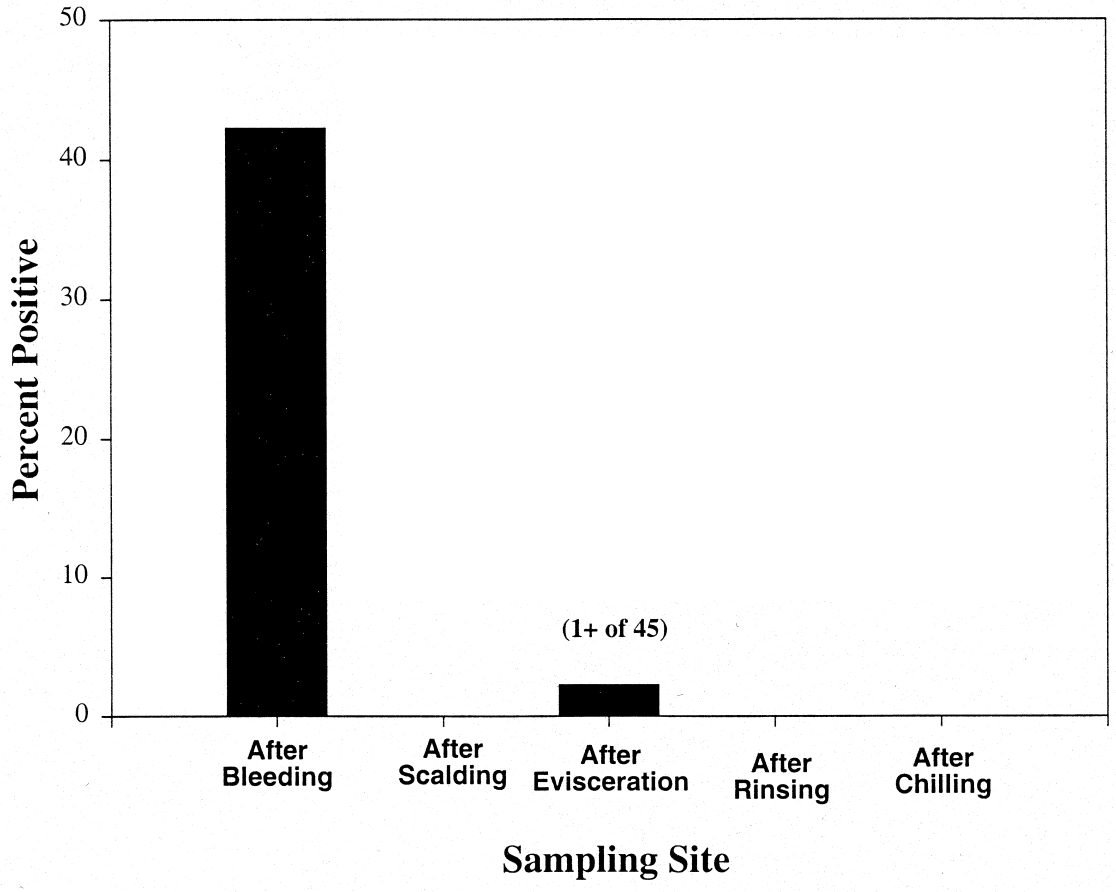

Figure 3. Average populations of mesophilic aerobic bacteria, coliforms, and *Escherichia coli* Biotype I on hog carcasses at five locations in a slaughter establishment using the skinning process.

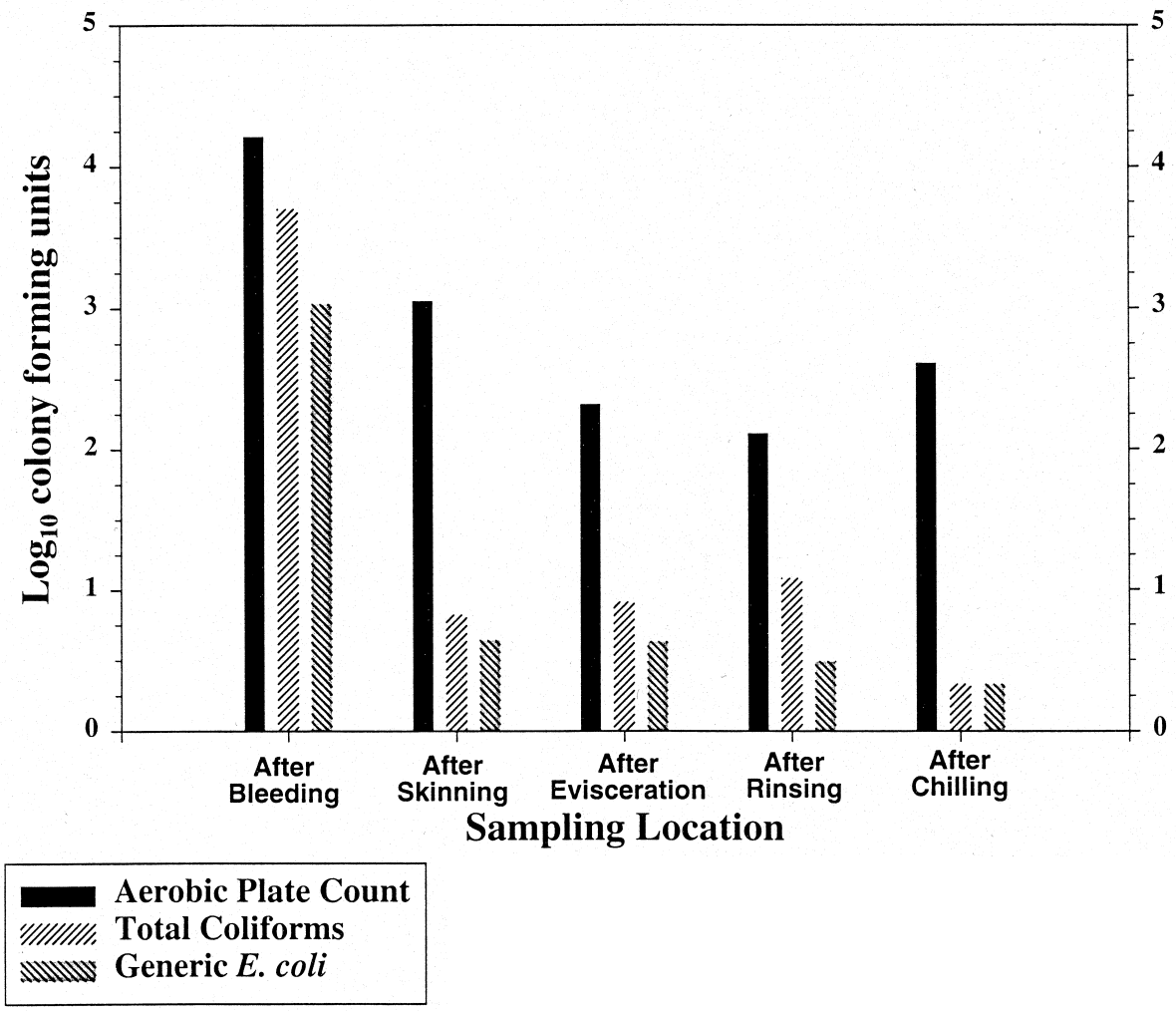

Figure 4. Incidence of salmonellae on hog carcasses at five locations in a slaughter establishment using the skinning process.