EVALUATION AND CONTROL OF MICROBIAL CONTAMINATION OF PORK

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SUMMARY

Bacterial contamination levels of pork carcasses and primal loins were evaluated at selected sites throughout the slaughter and fabrication processes of three typical U.S. pork plants. In the first phase of this study, which concentrated upon fabrication areas, psychrotrophic counts were significantly higher ($P<0.05$) just prior to boning and trimming, and at packaging. Coliform and mesophilic aerobic counts were highest at the sampling point immediately before loin boning.

In the second phase of this study, which concentrated on non-meat contact surfaces, contamination was higher on surfaces on the boning line, than the cutting line. However, there was not a major difference between the contamination levels of the different non-meat surfaces.

Boneless pork loins were significantly higher in psychrotrophic counts before boning and after boning, than after trimming (immediately before packaging).

Introduction

It has been known for many years that the initial level of bacterial contamination significantly affects the shelf life of chilled meat (Haines and Smith, 1933; Ingram, 1949), and some of the sources of contamination on pork carcasses have been known as well (Haines, 1933; Ingram, 1949; Ayres, 1955). Ingram (1949) categorized the origin of bacteria on pork as being either intrinsic or extrinsic. Intrinsic bacteria originate in the intestines of hogs and extrinsic bacteria are those found elsewhere in the environment. Researchers have reported that meat from healthy animals can be considered sterile at the time of slaughter and that the shelf life of meat depends on contamination from extrinsic bacteria (Gill, 1979). Several European researchers have studied the effects of slaughter on the amount of contamination on pork carcasses (Ingram and Roberts, 1976; Gerats et al., 1981; Snijders, 1988).

Little research has been done in recent years, however, in high speed U.S. pork plants, on determining the number of microorganisms on pork carcasses, plus identifying and prioritizing the main sources of this microbial contamination, either intrinsic or extrinsic. Homann et al. (1994) found that contamination on fresh pork was higher during fabrication of carcasses than during slaughter, in U.S. pork plants. This work supported results of others who found that either cross-contamination by hands of personnel doing cutting and fabricating (Pether and Gilbert, 1971) or inadequate cleaning and sanitizing of equipment and contact surfaces (Williams et al., 1983) are major causes of contamination of fresh meat.

The purpose of this study was to determine more specifically where in the fabrication process that microbial contamination of pork was greatest, and to determine if the contamination was from intrinsic or extrinsic sources. The ultimate goal of this project is to determine where changes need to be made to ultimately extend the shelf life and safety of fresh, chilled vacuum packaged pork.

Materials and Methods

Phase 1

Four sampling sites were identified during the fabrication of pork loins, based upon results of Homann et al. (1994). These sampling sites and surfaces included: 10 chilled carcasses, immediately prior to cutting; 10 pork loins after being pulled from carcasses; 10 pork loins immediately prior to trimming and deboning; and finally, 10 boneless loins at the point of vacuum packaging. Five randomly selected, vacuum packaged pork loins were also purchased at each plant and brought back to Iowa State University (ISU) for sampling after four weeks of storage at 2°C.

Microbial testing for meat surfaces included the following types of organisms: psychro-trophs, coliforms, and aerobic mesophiles. The packaged loins, which were held for four weeks before sampling, were sampled for the above organisms, plus anaerobic mesophiles and lactic acid bacteria. Surface pH and quantity of accumulated purge were also determined for each loin.

All samples were taken by a sterile swab technique and plated out in duplicate, using standard methods fo r the different types of microorganisms. Coliforms were enumerated using Trypticase Soy Agar (TSA), with a double strength overlay of Violet Red Bile Agar (VRB) at 35°C for 48±2 hours. Total aerobic counts were determined by using TSA agar, incubated at 30°C for 48±2 hours. Psychrotrophs were enumerated on TSA agar, incubated at 5°C for 10 days.

Total anaerobes were enumerated on Brain Heart Infusion Agar(BHI), while the lactics were grown using lactobacillus-specific media (LBS) and both types of microorganisms were incubated at 30°C for 48±2 hours. Both the total anaerobes and the lactics were held in an anaerobic environment, attained by placing the plates in a sterile Nylon/PVDC/EVA laminate vacuum packaging bag (Curlon 862, Curwood, Inc.) and vacuum packaging them using a Model A300 vacuum packaging machine (CVP Systems, Inc.), followed by back-flushing with a gas mixture of 40 percent carbon dioxide (CO_2) and 60 percent nitrogen (N_2).

Phase 2

Twenty-two non-meat contact surfaces were identified during cutting and fabrication of pork loins. The non-meat contact surfaces included: loin saddles, rubber gloves, conveyors, safety gloves, wizard knives, boning knives, and draw knives on the cutting lines, plus boning knives, rubber gloves, cotton gloves, mesh/safety gloves, cutting boards, loin saddles, wizard knives, and conveyors on the fabrication lines. Loin surfaces were sampled before boning, after boning, and after trimming (immediately before packaging).

Microbial testing for both meat and contact surfaces included the following types of organisms: psychrotrophs, coliforms, and aerobic mesophiles, using the methods described in Phase 1.

Both phases were replicated three times in each of three plants. Bacterial counts were converted to logarithmic numbers, which were analyzed using the Statistical Analysis System (SAS Institute, Inc., 1986) according to General Linear Model (GLM) procedures. An analysis of variance was used with a comparisons of means made according to Least Significant Differences (LSD).

Results and Discussion

Phase 1

The highest psychrotrophic contaminati
on was observed just prior to trimming and deboning and immediately before packaging of pork loins (Sites 3 and 4, Table 1). Chilled carcasses, prior to cutting, and loins after being pulled from carcasses (Sites 1 and 2), were significantly lower in psychrotrophic contamination.

Coliform contamination was found to be highest just prior to trimming and deboning and at the point of loin pulling (Site 2 and 3, Table 1). Chilled carcasses prior to cutting and boneless loins at the point of packaging were significantly lower in coliform counts than at the point immediately prior to trimming and deboning (Site 3). Mesophilic aerobe counts were highest prior to trimming and deboning (Site 3, Table 1). Aerobic contamination at Site 4 was lower, but not significantly ($P>0.05$).

Pork loins were also sampled after 4 weeks of vacuum packaged storage. In general, these loins were nearing the end of their useable shelf-life. There were no significant correlations found between any of these counts and either the pH or the purge that accumulated in the package after 4 weeks of storage (Table 2).

Phase 2

Microbial contamination was lower on non-meat surfaces on the cutting line (Table 3), than on the boning line (Table 4). This is most likely due to the fact that the human handling of pork loins is greater on fabrication lines (where loins are deboned and defatted), than cutting lines (where loins are cut from the carcasses). Also, knife sterilizers are not as available to workers on the fabrication lines, compared to the boning lines. Surfaces that the meat is most likely to come into contact with, as well as surfaces made of the more porous materials, appeared to be highest in contamination levels.The highest psychrotrophic contamination on the cutting line was observed on the loin saddles (Table 3). Loin saddles followed, but were not significantly ($p>0.05$) different from rubber gloves, metal conveyors, PVC conveyors, safety gloves, and wizard knives. Draw knives were significantly lower in contamination, probably due to the practice of frequently dipping draw knives into hot (82°C) water, in order to all

ow the knives to cut more easily through pork fat. Two items listed in Table 3 were sampled in only one of the three plants, therefore, the numbers were not included in the analysis, but were included in the table for relative comparison to other non-meat surfaces.

The relative ranking of coliform contamination on non-meat surfaces, was found to be very similar to that of the psychrotrophs (Table 3), however, as expected, the coliform counts were lower in every case than the psychrotrophic counts.

Mesophilic aerobe counts on non-meat surfaces were higher than either psychrotrophs or coliforms, and the ranking from highest to lowest level of contamination was different than the order used in Table 3, based upon psychrotrophic counts. Safety gloves had the highest level of mesophilic aerobic contamination, however, the level of contamination on safety gloves was not significantly ($p>0.05$) different from any of the other surfaces on the cutting line, except for the draw knives.

The highest psychrotrophic counts of non-meat surfaces on boning lines were found on straight boning knives (Table 4). Boning knife counts were not significantly ($p>0.05$) higher than those for the metal conveyors or the safety gloves, but were significantly higher than the counts for rubber gloves and wizzard knives. Boning knives may have moved to a higher ranking on this list, again as boning knife sterilizers are less available for use in boning areas. As on the cutting lines, wizard knives were significantly ($p<0.05$) lower in psychrotrophic counts than any other non-meat surface (Table 4).

Also, like the cutting line data, rankings of surfaces by levels of coliform contamination were similar to that of the psychrotrophs, with one exception - cutting boards, which were used in only one of the plants (Table 4). Again, the ranking of surface aerobic counts, differed somewhat from the ranking developed from the psychrotrophic counts (Table 4).

Boneless pork loins were significantly ($p<0.05$) higher in psychrotrophic contamination before boning and after boning, than after trimming (immediately before packaging) (Table 5). There were no significant ($p>0.05$) differences in either coliform or mesophilic aerobe counts,
between any of the sampling sites for the loins (Table 5).

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