Microbiology of Beef Carcass Surfaces

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ABSTRACT

In a survey at a local abattoir, agar sausage samples were taken at 10 carcass sites on each of 156 beef carcasses at different positions along the dressing line. The carcasses were selected to include all carcass types, viz. small (< 200 kg) and large (> 200 kg) as well as lean and fat carcasses. The 156 carcasses were divided into three groups of 52 carcasses each. Samples were incubated at three different temperatures to determine the aerobic count, mesophilic count and psychrotrophic count. Results of the survey showed that despite mean initial counts of 4.5 - 7.7 x 10^2, intermediate handling and the subsequent contamination that took place along the dressing line, the final chilling process rendered carcasses with acceptable bacterial levels (< 2.5 x 10^9).

Since the short shelf-life of fresh, chilled carcasses and cuts has been a problem since time immemorial (7, 10), one of the major aims of meat research is to increase the shelf-life. The first signs of putrefaction begin to appear when the bacterial count reaches 10^7 per g of meat. The initial number of organisms in muscle tissue, immediately after slaughter has been found to be 10^1 or 10^2 per g (8). When the number of bacteria on the surface of chilled carcasses reaches a count of 5 x 10^7 to 10^8 cm^-2, the meat develops an off-odor, discolors and finally the surface becomes sticky or slimy (1). This phase, the slime limit, is closely correlated to the bacterial count at the beginning of storage (1). The initial microbial count, therefore, generally greatly influences meat shelf-life (3, 8, 20).

Many bacterial genera are encountered on carcasses, but those of greatest importance to the meat industry are the pathogens and spoilage organisms (7, 10). The psychrophils, which grow most rapidly on carcasses and cuts during storage and handling at refrigeration temperatures, become the major organisms responsible for spoilage (5, 11, 12). The most commonly encountered bacteria on fresh meat are Pseudomonas spp., Moraxella spp., Acinetobacter spp., Microbacterium thermosphactum, and members of the Enterobacteriaceae (10, 11, 12).

The purpose of this study was to determine the aerobic count, mesophilic count and psychrotrophic count at specific sites on beef carcass surfaces and the influence of the dressing procedure on the magnitude of bacterial counts.

MATERIALS AND METHODS

In this survey, the agar sausage technique, using Standard 1 nutrient agar (Merck), was used (4, 9, 12) to determine the relative number of bacteria cm^-2. A modification of the method of Olggaard was used (4). The diameter of the agar sausage was decreased from the specified 3.4 cm to 2.86 cm, and Olggaard's table for "The mean bacterial count cm^-2 from the mean point value" was adapted by a factor of 1.41 to allow for the smaller sausage size. Samples were incubated at 37 C for 24 h for total aerobic mesophilic counts, at 5 C for 7 days for total aerobic psychrotrophic counts and 30 C for 24 h for total aerobic counts (7, 16, 23). One-way analyses of variance were carried out on transformed point values (\(\sqrt{x + 1}\)) (4). Where necessary, tests for least significant differences (L.S.D.) were performed (22). One hundred and fifty six beef carcasses were divided into three groups. Fifty two for the total, 52 for the mesophilic, and 52 for the psychrotrophic counts. Each carcass in each group was examined (at 10 locations) at four different positions along the dressing line. The carcasses were chosen at random and were sampled in groups of 2 to 3 at a time. Each carcass wascarmarked before dressing, and each group was followed along the dressing line up to the chilling rooms. Agar sausage samples were taken periodically along the sausage line at the following four positions: after flaying (BII); after evisceration and inspection (BII); after final washing and grading of carcasses (BIII) and after chilling at 3 to 5 C for 18 to 24 h (BIIV). The 10 sites on the left sides of carcasses which were examined are shown in Fig. 1. This procedure (7) was used to obtain the total, mesophilic and psychrotrophic counts, respectively. For determination of each of these counts, 52 beef carcasses were sampled. Each group of 52 carcasses, represented small (< 200 kg) and large (> 200 kg) as well as lean and fat carcasses, according to the domestic grading system.

RESULTS AND DISCUSSION

The agar sausage technique was used since it is the least time-consuming to perform, no damage is inflicted on the carcass and the results obtained can be expressed as the relative number of organisms present per square cm of surface area.

Analyses of variance were carried out to determine the significance of the influence of the dressing procedures on the microbiology of beef carcass surfaces as well as to
see if any interaction existed between carcass position, dressing line position and carcass type.

Counts for 10 carcass sites, four dressing line positions and four carcass types were tested by three-way analysis of variance. According to the F-values (Table 1), all the factors examined influence the bacterial counts on the carcasses. Figures 2, 3 and 4 illustrate the interaction between the factors examined. As shown in Fig. 2, 3 and 4, sites A6 and A5 were chiefly responsible for these interactions. These carcass positions (lower back - A5 and brisket - A6) were the most exposed to handling and thus explains the higher counts. The interaction which was found between the dressing line position and carcass type regarding psychrotrophs, is difficult to interpret.

### TABLE 1. Interaction between the counts on 10 carcass sites, four dressing line positions and four carcass types.

<table>
<thead>
<tr>
<th></th>
<th>Mesophiles (37°C)</th>
<th>Total aerobic count (30°C)</th>
<th>Psychrotrophs (5°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>59.23* * d</td>
<td>98.45* *</td>
<td>64.07* *</td>
</tr>
<tr>
<td>B</td>
<td>70.82* *</td>
<td>141.08* *</td>
<td>194.92* *</td>
</tr>
<tr>
<td>C</td>
<td>15.16* *</td>
<td>9.36* *</td>
<td>10.23* *</td>
</tr>
<tr>
<td>A × B</td>
<td>4.24*</td>
<td>4.62* *</td>
<td>3.29* *</td>
</tr>
<tr>
<td>A × C</td>
<td>1.01 NS*</td>
<td>1.03 NS</td>
<td>1.12 NS</td>
</tr>
<tr>
<td>B × C</td>
<td>2.34 NS</td>
<td>1.35 NS</td>
<td>3.44* *</td>
</tr>
<tr>
<td>A × B × C</td>
<td>0.58 NS</td>
<td>0.73 NS</td>
<td>0.53 NS</td>
</tr>
</tbody>
</table>

**a** - Carcass sites.  
**b** - Dressing line position.  
**c** - Carcass type.  
*d* - *P < 0.01.*  
*NS* - Non significant.

Figure 5 represents the mean aerobic counts obtained for mesophilic, total and psychrotrophic organisms. All the statistical differences on the dressing line were found to be significant at the 1% level (*P < 0.01*). The total counts were higher than the rest and may be therefore, as Roberts stated (18), more indicative of hygienic practice and also the shelf-life of the meat than other indicator bacteria or groups of bacteria. The mesophilic counts were in all instances higher than the psychrotrophic counts except after the final wash position where they were the same (Fig. S). This may have been due to the influence of the ambient temperature (20°C) together with the carcass temperature (37°C) during the dressing period which favors growth of mesophiles and limits that of the psychrotrophs.

When the dressing line positions are considered, it was found that the counts at the position after flaying (BI) were relatively high. This could have been caused by the large number of bacteria which were present on the hides of animals and in this way were introduced into the abattoir (5, 12, 17). Patterson and Gibbs (17) isolated few catalase-negative organisms but other gram-positive organisms included *Bacillus* spp., coryneforms, *M. thermosthaphactum* and coagulase negative cocci: They found that gram-negative organisms were widely...

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**Figure 1. Sampling sites on the carcass.**  
1. On distal extremity of *M. biceps femoris*.  
2. On central position of *M. biceps femoris*.  
3. On the medium plane of loin area.  
4. On caudal tip of *M. cutaneus trunci*.  
5. On the medial plane caudally to the scapula.  
6. On the caudal tip of the *Sternum*.  
7. On central position of shoulder.  
8. On central position of fore shank.  
9. On cut surface of neck area.  
10. On cut surface of neck in tracheal groove.
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Figure 2. Total Mesophilic counts at 37°C/24 h. Interactions between carcass sites (A1-A10) and dressing line positions. (B1) After flaying; (BII) After evisceration; (BIII) After final wash; (BIV) After 24 h of chilling.

Figure 3. Total aerobic counts at 30°C/24 h. Interactions between carcass site and dressing time positions. (B1) After flaying; (BII) After evisceration; (BIII) After final wash; (BIV) After 24 h of chilling.

Figure 4. Psychrotrophic counts at 5°C/7 days. Interactions between carcass sites (A1-A10) dressing line positions; (B1) After flaying; (BII) After evisceration; (BIII) After final wash; (BIV) After 24 h of chilling.

Figure 5. Mean aerobic counts at 37, 30 and 5°C taken at various positions on the dressing line. (B1) After flaying; (BII) After evisceration; (BIII) After final wash; (BIV) After 24 h of chilling.

distributed in the abattoirs; Pseudomonas spp. being present at most sites, while members of the family Enterobacteriaceae were isolated from all sites except carcass wash water and air samples in the lairages and a boning room. In the present study, samples were taken directly after flaying when the mentioned contaminating bacteria may have been present in the air and on the
meat.

The lower counts observed at the position after evisceration (BI) could have been due to a few factors not investigated in this study, viz. attachment of organisms to carcasses (2), a lower water activity (aw) at that point (10, 19) and the influence of complement (21).

It was found that at the position after the carcasses were finally washed and graded (BIII) a sharp rise in the level of counts occurred. This could be attributed to the cold water washing technique applied (3). Additional handling during grading as well as the biological condition of the washing water (+ 200 colonies ml-1) could also have contributed to the increase in the counts (17). The effect of the slaughter line - handling as well as general slaughter hygiene on carcass contamination could be reduced significantly by use of a hot water spray cabinet instead of the present cold water spray (3).

Following a chilling period of 24 h (BIV), a considerable decrease in all the counts was measured which was, according to different research workers (6, 15), an acceptable level of organisms cm-2. The decrease in the level of counts could be related to the chilling effect which caused the drop in temperature and aw (8, 10, 19). The latter factors brought the organisms into the lag phase and were thus responsible for the lower viability of those that survived the cold-shock imposed on them during the chilling phase. The present experiment also confirmed the original observation that the lower the initial count, the lower the final count (8). This accentuates the need for strict hygienic control in the pre-slaughtered animal, which would lower the initial microorganism level on carcasses and thus would produce carcasses with an increased shelf-life potential.

CONCLUSIONS

Carcass contamination does occur at different stages of the slaughtering process. Even though the chilling procedure decreases the counts of bacteria to an acceptable low level, use of a hot-water spray cabinet at the end of slaughter line could possibly lower the pre-chilling counts, which would result in even lower final post-chilling counts than those observed in the present study. The study also confirmed that the total aerobic count at 30 C/24 h is more indicative of the hygienic conditions in a slaughterhall than counts at other temperatures.

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REFERENCES


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