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High-Temperature Tenderizing of Beef Sides: Bacterial Considerations†

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A microbiological study of an experimental beef-tenderizing treatment, in which lean sides are held at 37°C until transfer to a chiller at 3 h postmortem, was made. The treatment did not cause a significant increase in bacterial numbers or a proliferation of potential pathogens or food-spoiling organisms.

It has been proposed that the usually superior tenderness of fat beef is due largely to the slower cooling rate of the well-insulated carcass during the first 2 to 4 h postmortem (5). The suggestion is supported by recent evidence that the tenderness of lean beef is enhanced considerably if the dressed sides are held at 37°C before normal chilling is begun at 3 h postmortem (6). Because of its organoleptic effectiveness, this process is of potential interest to the meat industry.

Beneficial though it may be to tenderness, however, the intentional exposure of fresh meat to this "hotbox" treatment might be expected to stimulate rapid microbiological growth. Significant effects on bacterial proliferation would not be anticipated within the deeper musculature, for the process imposes an internal lean-side cooling rate closely resembling that of a fat side during normal chilling. However, the time-temperature relationship on the surface of the hotbox side is very different from that on the normally chilled side: the hotbox side remains at or close to 37°C throughout the heat treatment, whereas the normally chilled side falls quickly toward the chiller temperature (0 to 5°C). Surface bacteria might thus be encouraged to multiply rapidly during hotbox exposure, particularly since most bacteria associated with meat are commonly found in the environment and occur only on the carcass surface (2). The present study was undertaken to investigate the effects of early-postmortem, high-temperature treatment on the growth and types of contaminating microbial floras on beef carcasses.

Eleven beef carcasses were routinely dressed, split, and washed shortly after slaughter. Not more than three animals were used per day so that we could obtain a more representative cross section of cattle and of possible variations in levels of contamination. About 40 min postmortem, one side of each carcass was railed into a conventional chiller (temperature, 0 to 2°C; relative humidity, 60 to 84%). The other side was railed into an adapted chiller, where it was treated at 37°C until 3 h postmortem (relative humidity, 22 to 48%); it was then transferred to the chiller, which was already occupied by the conventionally chilled side. At 24 h postmortem, a square (2.5 by 2.5 cm) of surface tissue was excised from each side with a sterile scalpel, forceps, and template. The sampling site was just below the sternum, and we attempted to obtain samples of a consistent thickness (≤1 mm). Each sample was treated in a stomacher (model 400 Stomacher Lab-Blender; Dynatech Laboratories, Inc.) with 100 ml of sterile 0.1% (wt/vol) peptone, serially diluted, and inoculated onto poured plates of plate count agar (PCA; Difco Laboratories). Two plates per dilution were incubated aerobically at room temperature (23 to 26°C) for 48 h, after which the plates were examined and the numbers of bacterial colony-forming units per 6.25 cm^2 were calculated.

The compositions of the surface microfloras at the 24-h sampling time were determined from surface tissue samples taken from both sides (hotbox and control) of one carcass. Inoculated PCA plates were incubated at 37°C for 48 h and at 5°C for 21 days for the respective enumeration of mesophiles and psychrotrophs. Colonies from each original PCA plate were selected for identification by a replica plate technique (1, 4). Isolated colonies from the selective differential medium plates were coded with respect to the master PCA plate and transferred to nutrient agar slants. Isolates were identified to the genus level by standard biochemical, differential, and morphological tests.

The counts for tissue samples excised from both sides of each carcass at 24 h postmortem

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TABLE 1. Log_{10} counts (per 6.25 cm^2) of hotbox and chilled sides at 24 h postmortem

Carcass no.	Hotbox[a]	Chilled[b]
1	5.36	4.67
2	4.64	4.00
3	5.54	4.34
4	4.76	4.08
5	4.04	3.97
6	4.87	4.73
7	4.08	4.14
8	4.84	3.75
9	4.14	5.04
10	3.82	3.63
11	3.98	4.41

[a] Log_{10} of mean, 4.90.
[b] Log_{10} of mean, 4.46.

are given in Table 1. Counts, reported as log_{10} colony-forming units per 6.25 cm^2, were higher on hotbox sides than on conventionally chilled sides in five comparisons and lower in two; in the remaining four, differences were less than 0.2 log_{10} unit, corresponding to a count ratio of one treatment to the other of less than 1.6. Statistical analysis by Student's t test of the differences between the results of the paired comparisons before conversion to logarithms indicated that there was no significant difference between the counts from the two treatments ($P > 0.05$). Therefore, although often leading to somewhat heavier growth, the hotbox treatment did not result in significantly enhanced proliferation.

The contaminating surface microfloras at the end of the 24-h period were composed of *Micrococcus* spp., coagulase-negative *Staphylococcus* spp., *Pseudomonas* spp., *Bacillus* spp., and nonpigmented pseudomonads. The microflora compositions determined from the 37°C-incubated samples of beef subjected to the two treatments differed appreciably from each other (Table 2). Localized differences between sites in initial contamination (3) may have contributed to this result; alternatively, the predominance of nonpigmented pseudomonads on the treated side may have reflected the tolerance of these organisms for low a_w conditions. Whatever the reasons for the difference, the results indicate that the treatment did not selectively encourage flora with a food-spoiling or pathogenic significance greater than that of the flora displaced by the treatment.

TABLE 2. Microflora compositions at 24 h postmortem

Organism	Hotbox		Chilled	
	37°C	5°C	37°C	5°C
Micrococcus spp.			11	
Coagulase-negative *Staphylococcus* spp.	7		19	
Pseudomonas spp.			33	
Bacillus spp.	8		37	
Escherichia coli	1			
Nonpigmented pseudomonads	83	100		100
Unidentified	1			

We conclude that under the conditions of the laboratory abattoir, the apparently radical hotbox tenderizing treatment does not cause a significant microbial deterioration of beef. We recognize, however, that sanitation standards may vary widely among slaughter facilities; the process should thus be considered for industry only after further extensive studies have been made under conditions of greater initial contamination.

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