DECONTAMINATION OF BEEF CARCASSES WITH HOT WATER

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SUMMARY

Laboratory experiments using pieces of fresh beef inoculated with *Escherichia coli* showed that approximately 99.9% of these organisms could be destroyed *in situ* by applying water at a temperature of 80°C for 10 s. This was accomplished without permanently damaging the surface tissues of the meat to any disagreeable extent.

Using this information a hot-water decontamination cabinet was designed and constructed. Tests showed that with a film of water at 83.5°C and an exposure time of 10 s, a mean reduction of at least 99% of inoculated *E.coli* could be obtained over a side of beef from a freshly slaughtered animal. An even larger mean reduction (c. 99.9%) was obtained if the exposure time was extended to 20 s. In neither instance was the appearance of the side of beef permanently impaired. After about 15 min at room temperature the surface tissues regained almost all their normal colour and the side was regarded as commercially acceptable.

INTRODUCTION

Bacteria capable of causing food poisoning have been isolated from all the common animals and poultry used for human nutrition. In fact, it is believed that animals and poultry used for human food are the major reservoir of these organisms, constantly being carried to the human consumer on dressed carcasses and raw meat (Bowman 1965; Hobbs 1965; Bryan 1980).

The organisms most commonly regarded as food-borne pathogens are the salmonellas - at last count there were over 2,500 known serotypes - and some countries such as Sweden have made heroic efforts to eradicate these bacteria from farm animals and human food. However, during the last decade, other organisms have also been implicated as food-borne pathogens capable of causing severe illness. These include *Yersinia enterocolytica*, *Aeromonas hydrophila*, *Campylobacter jejuni* or *coli*, and enteropathogenic *E.coli*, especially the strain 0157:H7 which causes haemorrhagic colitis or "bloody diarrhoea". Certainly each of these organisms has been isolated from meat in several countries and from the vicinity of abattoirs in Australia.

Recently, some alarm has been expressed, especially in the United States of America, regarding the presence of antibiotic-resistant *E.coli* and antibiotic-resistant salmonellas on meat (Bischoff 1987; Schell 1987). Because of the method by which cattle are raised in Australia, usually on open pastures or range land, these types of organism are probably not of any great importance in this country but they possibly could become more prevalent in future with the spread of intensive-rearing practices.

In spite of the strictest standards of hygiene, some potential food-poisoning organisms are still transferred to the outside surfaces of carcasses during the slaughtering and dressing operations in abattoirs. Therefore an investigation was undertaken to determine whether a process could be developed that would destroy these adventitious organisms *in situ* on sides of beef.

From the outset, we took the view that hot water, if effective, would be the most acceptable killing medium. This might not be so with irradiation, U.V. light, microwave heating, steam, a naked flame, hydrogen peroxide, or the application of organic acids such as acetic or citric acids.

This paper describes the results of experiments to determine the destruction of *E.coli* and (by inference) other similar organisms on beef using water at different temperatures, and the development and testing of a commercial process for treating sides of beef in abattoirs.

EXPERIMENTAL METHODS

Decontamination of meat pieces

Briskets, with the subcutaneous layer of connective tissue still present, were taken from sides of cattle carcasses within two hours of slaughter of the animal and cut into squares c. 10 cm per side and about 2.5 cm thick. They were inoculated by swabbing a culture of *E.coli* (grown in Oxoid nutrient broth at 37°C for 24 h) liberally over the original outside surface and allowed to dry at room temperature (22°C) for 30 min. Tests showed this method resulted in c. $10^{6.5}$ viable cells per cm of surface tissue.

Tap water, adjusted to various temperatures, was poured over the inoculated pieces of meat for the required time intervals. The number of *E.coli* present were estimated

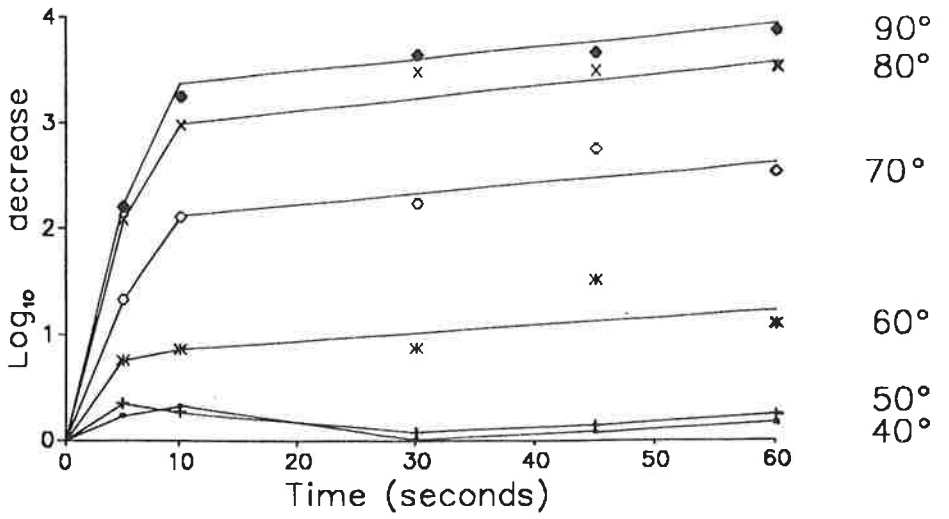

Fig.1. Decrease in the Log_{10} number of E.coli inoculated on pieces of fresh beef after the application of water at various temperatures for different times.

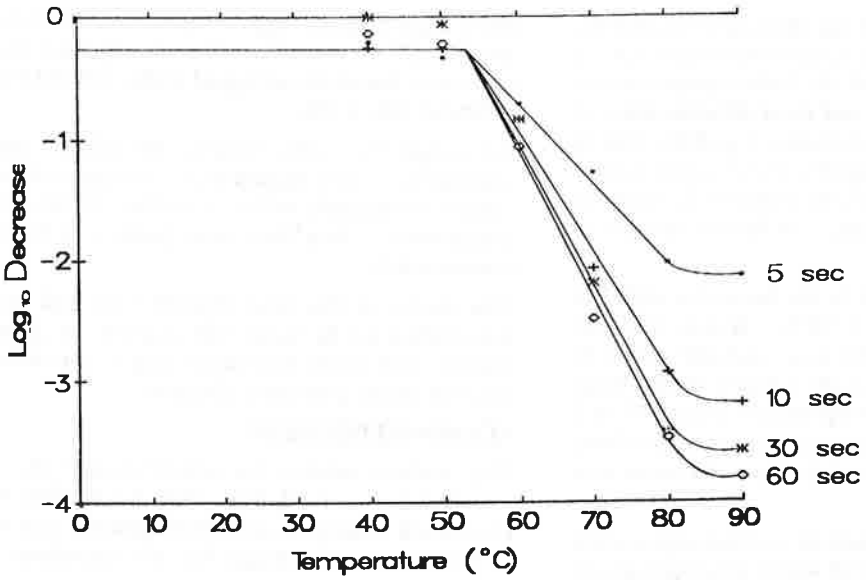

Fig.2. Decrease in Log_{10} number of E.coli inoculated on pieces of fresh beef after the application of water at various temperatures for different times.

before and after treatment. Ten tests were made at each time interval for each of the temperatures used.

A sharp, sterile cork borer (5 cm^2 cross-section) was used to mark out two areas on the meat. These were excised aseptically, placed in a sterile blender jar (Sunbeam Corp. Ltd.), 90 ml of sterile 0.1% peptone water added, and the meat tissue was blended at 20,000 rpm for 30 s. Then, either 0.1 ml of the blend, or of 10-fold dilutions of it, were spread over the surface of TYSG agar plates (Oxoid Tryptone Soya Agar to which 2 g glucose and 2 g Oxoid yeast extract were added per 1000 ml). The plates were incubated at 37°C for 24 h. The lowest count which could be obtained using this technique was 10^2 organisms/cm^2.

Decontamination of beef sides

Dressed sides of beef from cattle slaughtered no more than about one hour beforehand were inoculated by swabbing a suspension of *E.coli* cells liberally over the freshly exposed surface tissues. A wad of cotton wool about 15 cm square was soaked repeatedly in the bacterial suspension and rubbed over all the exposed meat tissue. It was found that three litres of such a suspension was enough to completely inoculate a side of beef in this way. The sides were then allowed to hang for another 15 min to let any excess moisture drain off before the initial samples were taken. This method of inoculation resulted in initial counts of at least 10^6 viable cells per cm^2 over the entire surface of each side of beef.

The sides were treated in a novel hot-water decontamination cabinet for either 10 or 20 seconds with water at different temperatures (Davey and Smith 1988). An average temperature (T_f) of the film of water flowing over the whole side was calculated (Davey 1988a). The temperature of the water in the reservoir which feeds the decontamination unit was also recorded.

Surface tissue samples were taken and treated in the manner described above. Six sites on each side were sampled - the neck, thoracic cavity, rump, mid-back, brisket and shoulder - and 2 x 5 cm^2 areas of surface tissue were taken in duplicate both before and after the decontamination treatment.

RESULTS AND DISCUSSION

The decreases in the log_{10} counts of the number of inoculated *E.coli* on pieces of beef treated with water at various temperatures and for different times are shown in Fig.1. These results are very similar to those obtained previously (Smith and Graham 1978). However, in the present experiments the surface area of a fresh beef carcass was used and a treatment time of 5 s was included.

Very few organisms were removed with water at either 40° or 50°C even with 60 s treatment (no more than c. log 0.2 - or less than 20%). As the temperature was raised to 80°C larger decreases were obtained. Beyond this temperature, little further reduction occurred. Furthermore, it was found that 5 s treatment is too short

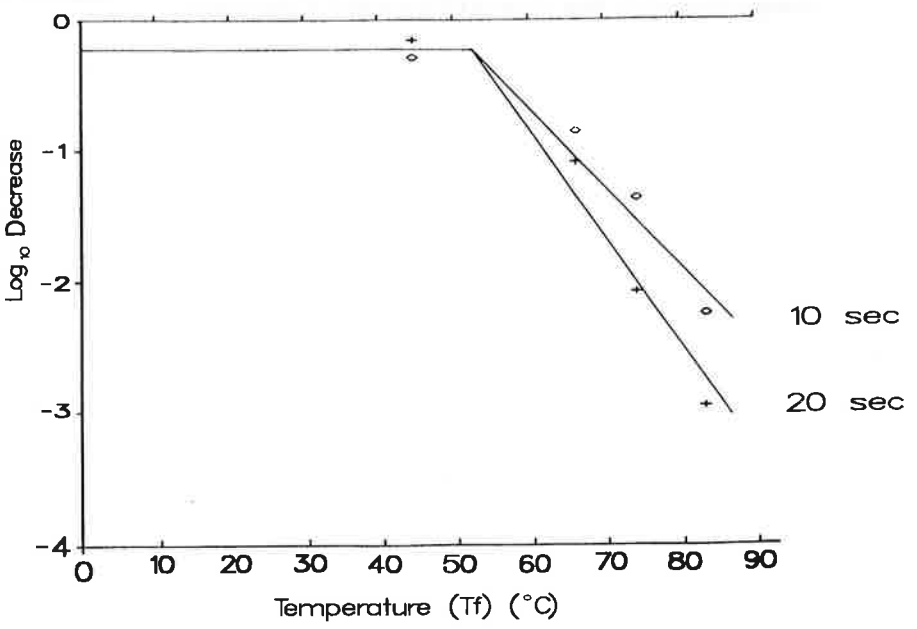

Fig.3. Decrease in Log_{10} number of E.coli inoculated on beef carcasses after treatment in a decontamination cabinet with water at different temperatures for either 10 or 20 s.

a time to obtain the full effect of any of the heat treatments applied. Beyond 10 s, further reduction in numbers of organisms was slight at any of the lethal temperatures used. Therefore the shortest and most effective time of treatment would appear to be between 5 and 10 s and, if the lines of the graphs are extrapolated to dissect between these time intervals, this can be calculated to lie between 7 and 8 seconds. These results can be rearranged to illustrate other points (Fig.2).

There was no lethal effect due to the hot water until the temperature reached at least 54°C. Below this any decrease can be regarded as due to a "wash-off" action of the film of water flowing over the surface of the meat tissue. Again, increasing the temperature above 54°C led to greater removal of the organisms present up to about 82-83°C after which little or no further decrease was found.

The pieces of meat had a bleached, cooked appearance immediately after treatment with water at temperatures of 70°C or above. The normal colour soon returned to the surface tissues after treatment at all temperatures up to and including 80°C. At 90°C, however, with an exposure time of as little as 10 s, this colour change was permanent.

The data obtained from laboratory experiments were used to design and construct a novel hot-water decontamination cabinet (Davey 1988a). This was tested using whole sides of beef from freshly slaughtered animals (details given by Davey 1988b). The mean $\log_{10}$ decrease on six sites on each of two sides treated in this cabinet are shown in Fig.3.

Again, almost no decrease occurred using water at a temperature less than about 54°C. Below this, any removal can be regarded as due to a "wash-off" effect and is quite small (c. $\log_{10}0.2$ or 20%). Above 54°C, the higher the temperature of water used, the greater was the decrease in the numbers of viable *E.coli*. Also, when the temperature of the film of water (T_f) was 83.5°C there was more than a mean $\log_{10}2$ reduction (99%) over the six sites tested on two sides after an exposure time of 10 s, and more than a mean $\log_{10}3$ reduction (99.9%) if a 20 s exposure was used.

Although the sides looked bleached and cooked immediately after treatment, the normal colour returned almost completely within a further 15-20 min at room temperature when they were judged to be acceptable commercially.

The choice of the most suitable time and temperature parameters to be used will depend on a cost/benefit analysis and could vary according to the circumstances existing at any particular abattoir.

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INVERTED DEER DRESSING

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A machine has been developed by Miller Engineering, a Dunedin (NZ) firm, and the Invermay Agricultural Centre, which removes hides from deer carcasses. The prototype has been in use at Invermay for 2 years and the first commercial plant was commissioned at Feilding in November 1987. There is a 10 minute video which displays the operation of the machine. One person can remove the hide from red deer carcasses at a rate of 12-15/hour without putting a hand or knife on any part of the valuable saddle/back legs of the carcass. Surface bacteriological counts are reduced to negligible values.