Oberflächendekontamination - eine neue Verarbeitungseinheit für die bessere Hygiene auf dem Tierkörperfleisch

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Obwohl man sich während der Verarbeitung sehr vorsichtig benimmt, sind Tierkörperoberflächen trotzdem immer mit Bakterien verunreinigt. Obgleich die meisten Organismen unschädlich sind, ist diemikrobiologische Situation der Tierkörper wichtig für jede Fleischindustrie, die vom Ausfuhrhandel abhängig ist, wo mikrobiologische Spezifikationen in den Forderungen der Käufer einbezogen werden können.

Diese Arbeit diskutiert die Wirksamkeit von heißem Wasser für die Vernichtung der Bakterien auf den Tierkörperoberflächen. Es beschreibt die Versuche im Labor und Versuchsanlagen, die zum Bau einer serienmäßigen Dekontaminationsanlage auf der Schafschlachtlinie des 2,500 Tierkörper täglich verarbeitenden Schlachthofes führte. Die Anlage besteht aus einer Heißwasser ($90^{o}C$) Spritzzone und Vorkammern mit zwei Reihen der Doppeltüren an jedem Ende. Die mittlere Erniedrigung von $\log_{10}$, die in der Anzahl von inokulierten E. coli auf der äußeren Tierkörperoberfläche registriert wurde, war 3.39. Die mittlere Erniedrigung der normalen Coli Verunreinigung auf dem Tierkörper war $\log_{10}$ 2.5. Obgleich die Behandlung den Tierkörper entfärbte, wurde der Farbton von Fett, Bindegewebe und Muskel bald gänzlich wiederhergestellt.

Die auf der stündlichen Produktion von 420 Tierkörpern basierte ökonomische Verwertung der Einheit wird beschrieben.

Pasteurisation - A new processing unit for improved hygiene on carcass meat

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Although great care is taken during processing, carcass surfaces are always contaminated with bacteria. Although most of these organisms are harmless, the bacteriological condition of carcasses is important to any meat industry which depends on export markets, where microbiological specifications may form part of the buyers standards.

This paper will discuss the effectiveness of hot water for the destruction of bacteria on carcass surfaces. It will describe the laboratory trials and prototype cabinets which led to the development of an in-line pasteurisation cabinet on a sheep slaughter floor of an abattoir processing 2,500 carcasses per day. The pasteurisation cabinet consisted of a hot water ($90^{o}C$) spray zone and had ante chambers each end with two sets of double doors. The average $\log_{10}$ decrease recorded in the number of inoculated *E. coli* on the outer surface of the carcass was 3.39. The average decrease in the normal coliform contamination on the carcass was $\log_{10}$ 2.5. Although the treatment discoloured the carcass, the colour of the fat, connective tissue and muscle soon regenerated completely.

An economic appraisal of the unit, based on a throughput of 420 carcasses per hour, will also be described.

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Pasteurisation - une Unité Nouvelle de Traitement pour L'Hygiène Améliorée sur la Viande de Carcasse

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Quoigue un soin extrême soit pris pendant le traitement, les surfaces de carcasse sont toujours contaminées par des bacteries. Quand même la plupant de ces organismes seraientinoffensifs, l'état microbiologique des carcasses est important pour toute industrie de viande qui est tributaire de marchés d'exportation, où les spécifications microbiologiques peuvent faire partie des exigences des acheteurs.

Cet article discute l'efficuésté de l'eau chaude pour la destruction des bactéries sue les surfaces de carcasse. Il décrit les essais de laboratoire et les cabinets prototypiques qui ont mené au développement d'un cabinet de pasteurisation en série sur un dallage pour l'abattage des montons d'un abattoir produissant 2,500 carcasses par jour. Le cabinet de pasteurisation s'est composé d'une zone d'arrosage de l'eau chade (90°C) et a eu les antichambres aven deux jeux de doubles portes à chagne bout. L'abaissement moyen de $\log_{10}$ enregistré dans le nombre de *E. coli* inoculés sur la surface extériure de la carcasse a été 3.39. L'abaissement moyen de la contamination coliforme normale sur la carcasse a été $\log_{10}$ 2.5. Quoique le traitement décolorât la carcasse, la couleur de la graisse, du tissu conjonctif et du muscle a été bientôt rétablie complètement.
Une appréciation économique de l'unité, basée sur le rendement de 420 carcasses par jour, sera aussi donnée.

Пастеризация -- Новая обработочная установка для улучшения гигиены парного мяса.

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Несмотря на очень тщательную обработку, поверхность туш всегда загрязнена бактериями. Хотя большинство этих организмов безвредно, бактериологическое состояние туш важно каждому мясокомбинату который зависит от экспортной торговли, где микробиологические спецификации могут входить в нормы покупателя.
В настоящей работе обсуждается эффективность горячей воды для уничтожения бактерий на поверхностях туш и описываются лабораторные опыты и прототипы шкафов, которые привели к развитию шкафа для поточной пастеризации в овцеубойном цехе на бойне перерабатывающей 2500 туш в день. Шкаф для пастеризации состоит из зоны для опрыскивания горячей водой /90°/ и на каждом конце имеет предкамеры с двумя рядами двойных дверей. Среднее понижение $\log_{10}$ отмеченное в числе **E.coli** привитых на внешней поверхности туш, равнялось 3,39. Среднее понижение при нормальном колиформном загрязнении на туше было равно $\log_{10}$ 2,5. Хотя обработка изменяла окраску туш -- цвет жира, соединительной ткани и мышцы быстро возвращался к нормальному.
Описывается также экономическая оценка установки основанной на производительности 420 туш в час.

Surface Decontamination - A New Processing Unit for Improved Hygiene on Carcass Meat

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INTRODUCTION

Although every precaution is taken, some bacterial contamination of carcasses processed on a commercial killing line is inevitable. In an effort to reduce the levels of contamination on carcass meats, particularly those destined for international trade, regulatory bodies have demanded changes both in procedures and establishment structural standards. Whilst there has been definite improvement in visual hygiene standards the limited evidence available indicates that there has not been a corresponding improvement in the microbiological status of meat.

That visual standards cannot be equated with microbiological standards is supported by a recent paper (Ingram & Roberts, 1976) where carcasses were sampled from six U.K. abattoirs. The visual hygiene of these abattoirs ranged from excellent to poor. The mean total bacterial counts on meat from two excellent plants were $\log_{10}$ 4.18 and 3.91, and from two poor plants, $\log_{10}$ 4.70 and 4.52. The authors concluded that, "*changes in slaughter methods and in hygienic practice are, in fact, doing little to improve the bacteriological condition of carcasses.*"

Of the total number of microorganisms on a carcass, only a small proportion is of public health significance. One of the organisms which may be present is *Salmonella*, which is a major concern of meat processors.

Several methods to reduce the level of carcass contamination have been proposed. These include the use of water sprays at various pressures (Patterson [1972], Kotula [1974]) and temperatures (Patterson [1970], Bailey [1972]), and the use of water sprays with high concentrations of chlorine (Emswiler, *et al*, 1976).

Investigations on small meat samples inoculated with *E. coli* indicated that a significant reduction in the number of organisms on the surface could be achieved by exposure to water heated to above 70°C (Smith & Graham, in press).

Further time/temperature studies using carcasses demonstrated that the greatest number of organisms was destroyed without permanently impairing the appearance of the treated carcasses when water at 80°C was applied for 10 seconds. Immersion of sheep carcasses in hot water vats was then compared with a hot water spray treatment. The immersion method was found to be the more reliable, giving good reductions in numbers of contaminating coliform bacteria, both for external carcass surfaces and within the body cavity. Reductions in the order of 99% were obtained. The performance of a prototype open ventilated spray cabinet was much less satisfactory, the average reduction in the number of organisms being approximately 90%. The poor performance was due to a rapid cooling of the hot water after it left the spray nozzles. The spray, however, was considered to be simpler to incorporate into present dressing procedures and attempts were made to improve the spray cabinet design so that the cooling of water between spray and carcass is minimised.

A full-enclosed spray cabinet for the treatment of sheep carcasses was therefore constructed and evaluated.

CABINET DESIGN

Details of the cabinet for treating smallstock carcasses are given in Figure 1. The design refers to our pilot cabinet, and while this is fully capable of operating on a commercial dressing line, a permanently installed facility would probably incorporate minor modifications.

The spray zone is isolated from ambient conditions by the use of small ante-chambers at the entrance and exit. Each ante-chamber is provided with two sets of double doors and the length of the ante-chamber is such that at no time are both sets of doors fully open simultaneously.

The water spray pattern is arranged to cover the entire outer surface of the carcass. A total of 32 jets (Spray Systems Inc. Type U2520 vee jets*) are mounted on eight water distribution pipes, arranged along both sides of the cabinet.

A pump draws 4.5 ℓ/sec of hot water from the tank and delivers it at a pressure of 200 kPA to the distribution headers feeding the spray nozzles. The hot water, after passing through the spray nozzles, is returned to the tank.

A drive mechanism, independent of the main slaughtering chain, is required for the cabinet. This ensures that all carcasses are cleared from the cabinet and the spray time is constant for all carcasses.

*The selection of jets specified resulted from a study of spray patterns in relation to coverage and temperature drop with distance from the nozzle.

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CABINET EVALUATION

Laboratory Trial

Procedure

Sheep carcasses were transported to the treatment area immediately after they were dressed and six selected sites (rectal area, midback, brisket, neck and two sites inside the body cavity, i.e. anterior belly flap and in the kidney region) were liberally swabbed with an overnight broth culture of *E. coli*. The swabbed areas were allowed to dry for 20-30 minutes prior to sampling and spray treatment.

Thermocouples were inserted into the tank water, and just beneath the surface of the carcass at two sites, inside leg and midback. Temperatures were continuously recorded during the spray treatment, and each of the inoculated sites was sampled before and after treatment. Surface tissue samples of area 10 cm^2 were excised and placed in sterile polyethylene bags. Ninety-nine ml of sterile 0.1% peptone water was added to each sample, and the samples were then treated for one minute, with a Colworth Stomacher Model 400. Appropriate dilutions were pour-plated with Violet Red Bile Agar (Oxoid), and plates were incubated at 37°C for 24 hours so that counts of coliform bacteria could be obtained.

Results and Discussion

Five sheep carcasses, previously inoculated with *E. coli*, were each passed through the cabinet (tank water at 90°C, spray time 10 seconds). Surface temperatures of 80°C or slightly greater were consistently achieved when the tank water temperature was approximately 90°C (Fig.2). The average $\log_{10}$ decrease in the number of *E. coli* on the outside of the carcasses was 3.4, while the decrease within the body cavity was 1.3, i.e. equivalent to a total reduction in the bacterial population of between 93% and 99%. The decrease achieved on outer carcass surfaces was similar to that obtained by immersion in hot water (Smith & Graham, in press).

Industry Trial

The cabinet was installed in a commercial abattoir at the end of a mutton dressing chain, and investigations were undertaken to determine:

(i) The effectiveness of the totally-enclosed system for the removal of naturally occurring bacterial contamination, and

(ii) The effect of treatment upon carcass weight loss.

Procedure

Twenty-four dressed sheep carcasses were selected at random during normal sheep processing and assigned to one of two groups of 12. One group was designated to be treated with hot water and the other group was retained as a control group for the weight loss studies. All carcasses were weighed before and after the hot water treatment. Six carcasses from the treated group were sampled before and after treatment for microbiological analysis. These carcasses were treated in the spray cabinet (tank water at 90±1°C for 10 seconds). All carcasses were then transferred to a chiller at 0-4°C and reweighed approximately 24 hours after treatment.

The samples for microbiological analysis were obtained by excising 50 cm^2 of surface tissue from each of two selected sites (rectal area of rump, and brisket). Each sample was placed in a sterile polyethylene bag. Ninety ml of 0.1% peptone water was added and the sample was treated for one minute with the Colworth Stomacher. Appropriate dilutions were spread plated on tryptone-soya peptone-yeast extract-glucose agar and incubated at 25°C for three days to give a total aerobic plate count. Appropriate dilutions were also pour-plated with Violet Red Bile Agar (Oxoid) and incubated at 37°C for 24 hours to obtain a coliform count.

Results and Discussion

Reductions in numbers of bacteria are given in Tables 1 and 2. Mean reductions of $\log_{10}$ 2.5 are shown for both groups of bacteria.

Immediately after the hot water spray treatment the carcasses appeared cooked and bleached. However, normal colour was completely regained in all areas except the cut surfaces on the brisket and neck after the carcasses had been stored in a chiller at 1-4°C.

TABLE 1

Mean coliform counts for six naturally contaminated sheep carcasses treated in the cabinet

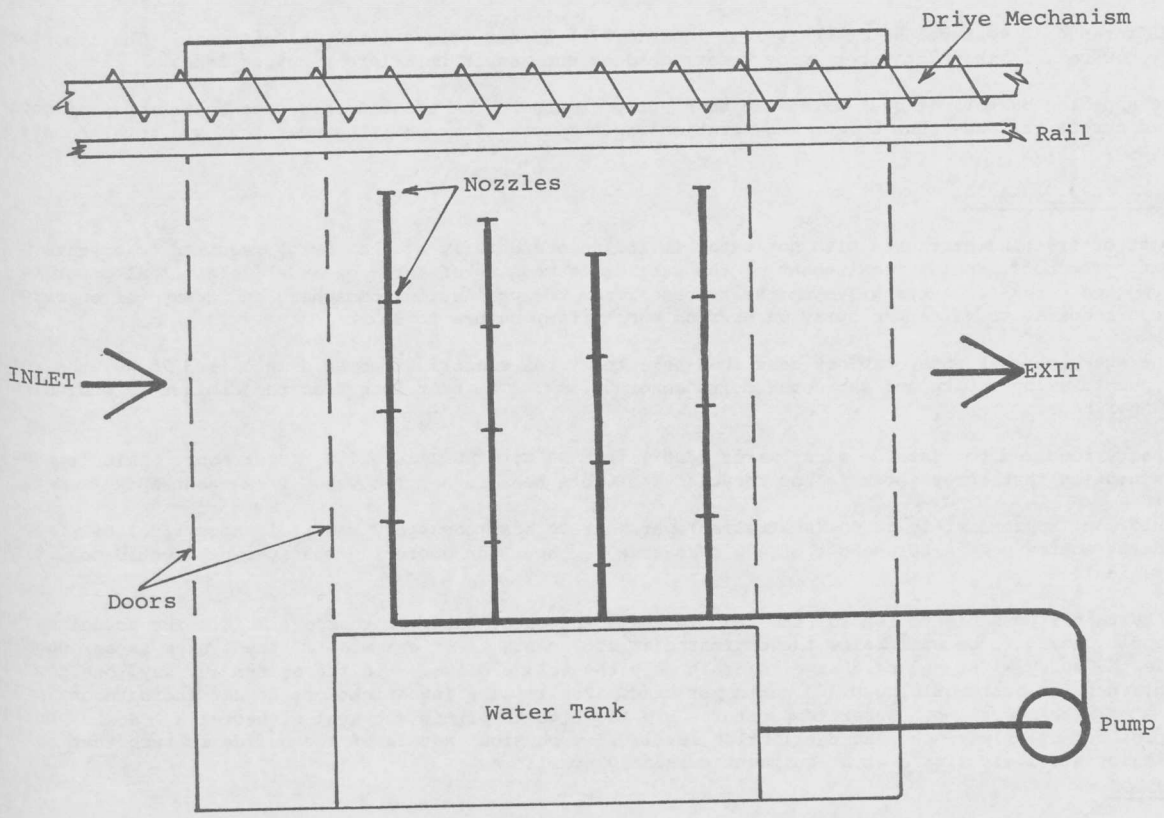
Area Tested	$\log_{10}$ Counts (Mean) Before Treatment	After Treatment	Decrease
Rump	3.4	1.0	2.4
Brisket	3.25	0.5	2.75
Mean	3.3	0.75	2.55

TABLE 2

Mean total aerobic counts for six naturally contaminated sheep carcasses treated in the cabinet

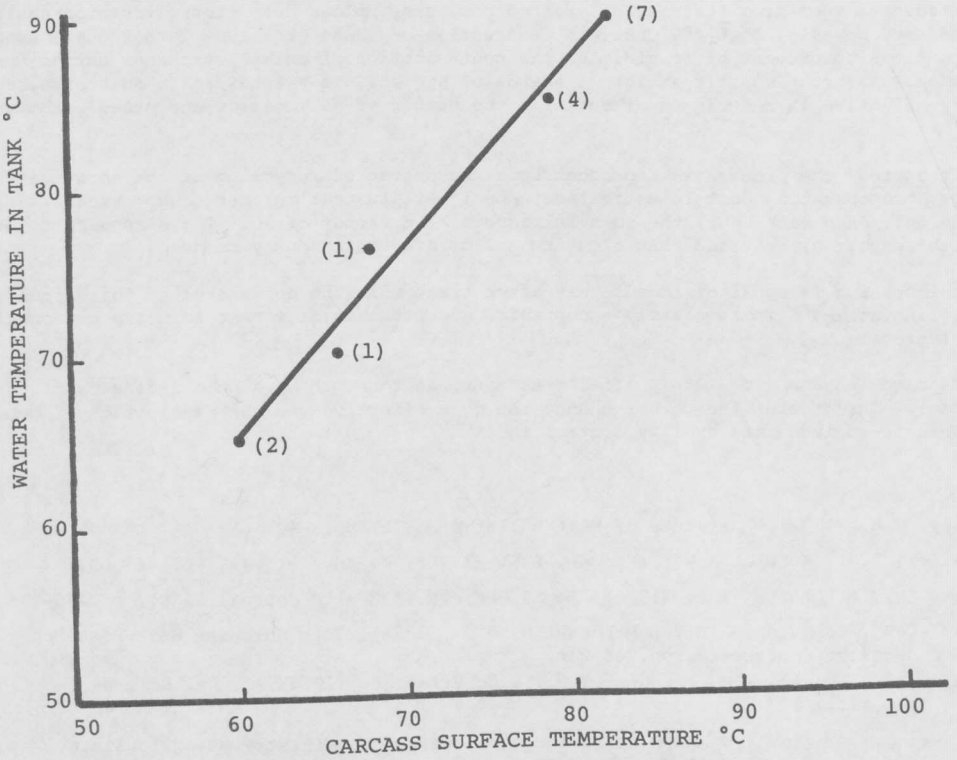
Area Tested	$\log_{10}$ Counts (Mean) Before Treatment	After Treatment	Decrease
Rump	4.8	2.1	2.7
Brisket	4.1	1.8	2.3
	4.4	1.9	2.5

Weight loss in the control group of 12 carcasses - hot wet weight to cold dry weight - ranged from 2.3% to 3.0%, with a mean value of 2.65%. Weight loss in the treated group ranged from 1.7% to 3.0%, with a mean value of 2.38%.



DIAGRAMMATIC SECTION THROUGH ENCLOSED SPRAY CABINET

FIG.1



RELATIONSHIP BETWEEN CARCASS SURFACE TEMPERATURE & TANK WATER TEMPERATURE IN ENCLOSED SPRAY CABINET

(numbers in parentheses indicate numbers of test carcasses)

FIG.2

The difference in mean values of the weight loss (0.27%) is not statistically significant. The important point, however, is that hot water spray treatment does not result in a larger weight loss.

Calves and hindquarters of beef have also been spray treated. The treated carcasses again appeared cooked on exposed muscle surfaces, but colour regeneration was complete after chilling overnight and total counts were reduced by 99%.

Economic Considerations

The cost of treating carcasses with hot water is influenced chiefly by the energy required to operate the cabinet. The total energy requirement of the cabinet is made up of three demands - electrical power to drive the pump and carcass conveying system, heat losses from the cabinet to atmosphere and carryover on carcasses, and heat required to raise the spray water from supply temperature to 90°

For the sheep carcass spray cabinet described here the total electrical power demand is 3.75 kw, the spray water pump drawing 3.0 kw and the screw drive motor 0.75kw. The heat loss from the cabinet is equivalent to 290 MJ per hour.

The energy required to heat the spray water (700ℓ) from 20°C to 90°C is 4,700 MJ per hour. This is based on the assumption that spray water is not recycled and waste heat is not recovered from spent spray water.

It would cost approximately $7.00 (Australian) per hour to heat the spray water, if heavy fuel oil is used as the energy source. At a throughput of 420 carcasses per hour the operating cost per head would be 1.67 cents (Australian).

It is certainly possible to recover the heat in the spent spray water or to recycle it. The actual cost per head could therefore be well below the estimated at 1.67 cents. For example, if the system is arranged to recycle the spray water and discharge to drain only the volume of water in the system in, say, one hour, i.e. 700ℓ/h, then the cost would be 0.167 cents per head. Preliminary investigations do not indicate any problems associated with recycling. Water temperatures are too high to permit survival of bacteria. Solids buildup is rapid, but quickly reaches an equilibrium level. The physical nature of the solids is such that solids removal is relatively simple with equipment currently available.

CONCLUSION

We have shown that the treatment of sheep carcasses with a hot water spray after completion of dressing can achieve a reduction of 99% or more in the numbers of organisms contaminating the outside surface of the carcass.

A similar decrease would be expected in the numbers of any *Salmonella* which might also be present (Smith & Graham, 1978). Providing the numbers of *Salmonellae* present are initially low, such a process should effectively eradicate them from the meat of treated carcasses unless deep tissue invasion has occurred. It must be emphasised, however, that the complete destruction of these organisms is not guaranteed and all possible precautions to prevent or to minimise the contamination of animal carcasses during dressing still have to be taken. Nevertheless, if strict standards of hygiene are maintained in abattoirs, such a treatment should be very effective in reducing substantially the number of *Salmonellae* and other pathogens present on meat.

The final unit cost of the process is dependent upon the degree of recycling of the spray water. With no recycled water, the operating cost is estimated to be 1.67¢ (Australian) per sheep carcass. With recycled water replaced only once each hour, the cost is reduced by a factor of 10. There appears to be no problem associated with recycling, provided that floating solids are continuously removed.

Although discolouration is apparent immediately after treatment, the appearance of the carcass after normal overnight chilling at 1-4°C is completely acceptable, and comments from meat industry personnel even suggested an improvement.

The degree of colour change immediately after treatment was found to be a good indicator of the effectiveness of the treatment. The greater the colour change the more effective was the destruction of contaminating organisms. This is an immediate quality control index.

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