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Cold water, ultra-high pressure cleaning of abattoirs

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SUMMARY

Cold water (10° C) at ultra-high pressure (38·5–49 kg/cm²) was compared with (*a*) hot water 65·6–82·2° C) at low pressure (4·2–5·6 kg/cm²) and (*b*) hot water containing a detergent (2 % (w/v) sodium silicate). Seven sites were examined in a beef abattoir and six in a bacon factory.

Three surfaces in the beef abattoir had lower residual colony counts (higher reductions) after hot water/low pressure than after cold water/high pressure. However, the differences were not significant ($P > 0{\cdot}05$). The range of the mean $\log_{10}$ count/cm² before cleaning was 4·02–5·15, and after cleaning 1·73–2·32 (hot water) and 1·9–2·85 (cold water).

On three of the remaining sites, the three methods were compared. The total differences between treatments were not significant ($P > 0{\cdot}05$), although there was an effect of surface and an interaction between surface and treatment. The cold water produced lower residual counts on three sites in the bacon factory than the hot water (45–54° C). However, the differences were not significant on the remaining surfaces.

INTRODUCTION

A previous investigation into the efficiency of cleaning methods (Dempster, 1971) showed that hot water (140–150° F) under pressure, with added detergent and 200 p.p.m. of available chlorine, was satisfactory for the cleaning of surfaces and equipment in a bacon factory.

Increases in the cost of oil for steam raising since the oil crisis of October 1973, and in the cost of detergents and detergent/sterilizing agents which have increased in price by up to 40 % since that time (J. Campbell, personal communication) has necessitated the investigation of other methods of cleaning. The present investigation was undertaken to compare the efficiency of cleaning by cold water (*ca.* 10° C) at ultra-high pressure (38·5–49·0 kg/cm²) with other methods commonly used.

In 1975, five trials were conducted in a beef abattoir slaughtering 200–220 cattle daily between April and October; six trials in a bacon factory slaughtering 350 pigs daily in November and December. The sites chosen for treatment are shown in Table 1.

MATERIALS AND METHODS

Cleaning

In the beef abattoir three methods were compared.

(1) Cold water (*ca.* 10° C) at high pressure (49 kg/cm²) from a pump* delivering 14 l/min for 60–90 s.

(2) Hot water (65·6–82·2° C) at low pressure (4·2–5·6 kg/cm²) from a steam hose delivering 45–70 l/min.

In three of the trials a brown-green scum developed on the tiled walls of the carcass washing bay after both cold and hot water treatments. In the remaining two trials a third method was introduced which consisted of brushing the tiled surface with a 2% (w/v) solution of sodium silicate at 68° C, followed by rinsing with cold water (Dempster, 1971).

In the bacon factory cold water (*ca.* 10° C) at high pressure (38 kg/cm²) from a pump† delivering 54 l/min for 60 sec, was compared with hot water (45–54° C) at low pressure (3·5–4·2 kg/cm²) from a steam hose delivering 36 l/min for 60 s.

Bacteriological counts

Bacteriological counts were carried out on each surface by swabbing before and after treatment four sites each of 100 cm² using a sterile metal template and four cotton-gauze swabs. The swabs were rubbed over the surface five times in each direction using moderate pressure (Patterson, 1971). They were pooled by transferring to 80 ml quarter strength Ringer's diluent + 0·1% peptone (Straka & Stokes, 1957) in a screw-capped bottle. Serial decimal dilutions were made in the same diluent, using a 1 ml 'Oxford' sampler pipette with a disposable tip (Oxford Laboratories, Athy, Ireland) by the method of Bousfield, Smith & Trueman (1973). Pre-dried plates of 'Oxoid' Plate Count Agar were divided into quarters and the surface inoculated with replicate 0·025 ml. amounts of sample using a 25 μl Oxford sampler. The plates were counted after 3 days at 25° C. A visual appraisal was made of surfaces before and after cleaning by members of the factory staff, veterinary officers and staff of this Institute.

Analysis of counts

An analysis of variance was performed on the log transformed colony counts in both experiments. The data were analysed as a split-plot design with surface (site) as the main plot factor and treatment as subplot factor. The *t* test was used for tests between individual means for a given surface.

RESULTS

In Table 2 is shown the reductions in count for four surfaces in a beef abattoir when cleaned by hot water/low pressure and cold water/high pressure. Surfaces

* Model no. 800E, Psimat Ltd, Henley-on-Thames, England.

† Jet-n-spray (700) pump, W.D.M. Plant Hire Limited, Exeter, England.

Table 1. *Sites for treatment*

	Beef abattoir	Bacon factory
1	Tiled wall, carcass washing bay	'Terrazzo' wall of bleeding passage
2	Tiled wall deheading area	Stainless steel dehairer platform
3	Stainless steel inedible fat chute	Blades of black scraper
4	Metal guard of backbone saw	Cutting table
5	Evisceration table	'Terrazzo' wall of boning hall
6	Stainless steel boning tables	Stainless steel table
7	Stainless steel boning tables	

Table 2. *Mean log_{10} reductions in count/cm² on four surfaces by two treatments (beef abattoir)*

		Treatment	
No.	Site	Hot water (65·6–82·2° C) at low pressure	Cold water (10° C) at high pressure
3	Stainless steel fat chute	2·73	2·70
4	Metal guard	2·29	1·62
5	Evisceration table	1·80	1·89
7	Stainless steel boning table	2·83	2·30

S.E. of difference between treatments: same surface = 0·412, D.F. = 16; different surface = 0·619, D.F. = 12·7.

Table 3. *Mean log_{10} reductions in count/cm² on three surfaces by three treatments (beef abattoir)*

		Treatment		
No.	Site	Hot water (65·6–82·2° C)	Cold water (10° C) at high pressure	Hot (68° C) detergent solution (2%, w/v)
1	Tiled wall of washing bay	−0·58	0·50	1·31
2	Tiled wall of deheading area	1·21	2·72	2·79
6	Stainless steel boning table	2·94	1·20	1·72

S.E. of difference between treatments: same surface = 0·726, D.F. = 12; different surface = 0·693, D.F. = 7·8.

Table 4. *Mean initial and residual counts (log_{10}/cm²) of surfaces cleaned by different methods (beef abattoir)*

No.	Site	Initial count	Hot water (65·6–82·2° C) at low pressure	Cold water (10° C) at high pressure	Hot (68° C) detergent solution (2%, w/v)
1	Tiled wall of washing bay	2·43	3·09	2·17	1·80
2	Tiled wall of deheading area	5·05	3·23	2·45	2·75
6	Stainless steel boning table	4·19	1·90	2·64	2·15

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Table 5. *Mean log_{10} reductions in count/cm² on six surfaces by two treatments (bacon factory)*

No.	Site	Treatment: Hot water (45–54° C) at low pressure	Treatment: Cold water (10° C) at high pressure
1	Terrazzo wall of bleeding passage	0·15	1·41
2	Stainless steel dehairer platform	−0·42	0·98
3	Blades of black scraper	1·07	1·96
4	Stainless steel cutting table	2·23	1·90
5	Terrazzo wall of boning hall	1·07	1·11
6	Stainless steel table	2·05	1·58

S.E. of difference between treatments: same surface = 0·353, D.F. = 30; different surface = 0·602, D.F. = 25·7.

Table 6. *Mean initial and residual counts/cm² of surfaces cleaned by different methods (bacon factory)*

No.	Site	Initial count	Residual count after cleaning by: Hot water (45–54° C) at low pressure	Residual count after cleaning by: Cold water (10° C) at high pressure
1	Terrazzo wall of bleeding passage	138,000	97,720 (70·81)*	5,370 (3·89)*
2	Stainless steel dehairer platform	6,457	16,980 (inc)†	661 (10·24)
3	Blades of black scraper	79,430,000	6,761,000 (8·51)	871,000 (1·10)
4	Stainless steel cutting table	37,150	219 (0·59)	468 (1·26)
5	Terrazzo wall of boning hall	8,511,000	724,400 (8·51)	676,100 (7·94)
6	Stainless steel table	134,900	1,202 (0·89)	3,548 (2·63)

* Survival (%). † Increase.

3, 4 and 7 had lower residual counts (higher reductions) after water cleaning. However, in no instance was there a significant difference between the two methods of cleaning, or a significant difference between surfaces and there was no interaction between them ($P > 0·05$). The mean log_{10} colony count/cm² before cleaning ranged from 4·02 to 5·15 and after cleaning, from 1·73 to 2·32 (hot water) and 1·9 to 2·85 (cold water). These results therefore suggest that cold water/high pressure is as efficient as hot water/low pressure in removing bacterial contamination.

The reductions in count on three other surfaces after cleaning by the three methods are presented in Table 3. The overall differences between treatments

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were not significant ($P > 0{\cdot}05$) although there was an effect of surface and interaction between surface and treatment ($P < 0{\cdot}05$). The mean initial and residual counts ($\log_{10}/cm^2$) for these surfaces are shown in Table 4.

The composite results of six trials in a local bacon factory are presented in Table 5. On sites 1–3 the cold water treatment produced higher reductions than the hot water treatment ($P < 0{\cdot}05$). However, on sites 4–6 the differences were not significant ($P > 0{\cdot}05$) although on sites 4 and 6, hot water-low pressure resulted in greater reductions. On average, the cold water/high pressure was more efficient than the hot water/low pressure ($P < 0{\cdot}01$) producing a log 0·39 better reduction than the hot. There were also significant differences between sites ($P < 0{\cdot}05$) and a significant interaction between treatments and sites ($P < 0{\cdot}01$).

The mean initial and residual colony counts and percentage survival for these surfaces are shown in Table 6.

DISCUSSION

In the beef abattoir brushing with a hot detergent solution produced a higher reduction (lower residual count) on the wall of the carcass washing bay than the other methods. This treatment also removed the staining on tiled walls. However, there was a net increase in bacterial numbers on the walls of the washing bay after hot water/low pressure washing. It is presumed this was due to a combination of factors, namely water temperature, low line pressure and recontamination. The mean water temperature was 66° C, which is short of sterilizing temperature (82° C) (McLaughlin, 1969). The recontamination was due to what is described as 'gravity soiling'. This term was coined to describe contamination which drains by gravity down a surface and applies particularly to vertical or inclined areas such as walls. The low line pressure was not sufficient to dislodge foci of contamination. However, recontamination did not occur on the wall of the 'deheading' area. A possible explanation is that the mean initial count (log 5·05/cm²) may have been greater than that of surrounding areas and therefore any combination of cleaning techiniques would result in a decrease in numbers.

In the bacon factory, recontamination occurred on one surface (site 2) which was an inclined platform attached to the dehairer machine. The residual counts were still high, ranging from 219 to 6,761,000/cm² (hot water) and 468 to 871,000/cm² (cold water), although the results were satisfactory in terms of percentage organisms surviving with the exception of site 1 (70·81 %). Similar results were obtained with meat mincing machines and recommendations were made to ensure that only small numbers of micro-organisms survive, e.g. 100/ml or 100/cm² at 22–25° C. (Dempster, 1973). The extremely high counts on the black scraper reflect the conditions which can exist when equipment of this type is not regularly cleaned. Earlier observations (Dempster, 1971) had shown that the undersides of the scraping blades were heavily contaminated with slime and time-consuming methods were required to remove this.

One recurring comment of the judges (bacon factory) was the unattractive 'greasy' film which persisted on surfaces after both methods of cleaning but especially when cold water was used. However, with few exceptions, the present

results have indicated that both cold water and hot water produced a low percentage survival of organisms.

Recommendations

Cold water at ultra-high pressure can be used in abattoir cleaning if the following conditions exist:

(1) The soiling is of recent origin, i.e. < 24 h old.

(2) Other methods are used, e.g. brushing with hot detergent solution, when a surface becomes visually stained.

(3) Cleaning is regularly carried out (hourly or daily). Cold water or even hot water (50–55° C) will not remove faecal staining, congealed blood or other types of 'hard soil' if allowed to dry on a surface.

(4) All surfaces are examined weekly to determine which system of cleaning is to be used.

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