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EFFICIENCY OF SEVERAL DECONTAMINATION HURDLES ON HYGIENIC QUALITY OF BEEF CARCASSES

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Introduction

Cattle arriving for slaughter can be very dirty, depending on the season and stabling conditions both on the farm and at the meat plant. Traditionally cattle are not cleaned before dehiding. This may cause a risk of pathogenic microorganisms spreading to the carcass during slaughter unless careful slaughter processes are applied. Another source of contamination of the carcass with pathogenic bacteria is the faecal contamination that can occur in connection with evisceration.

In recent years, a number of methods designed to improve hygiene on the slaughter line have been tested at Danish beef plants. Tests were performed to determine whether reduced scoring of the hide on the forelegs, neck and brisket and a new hide puller that pulls off the hide of the forepart of the carcass without scoring were capable of reducing the spread of *E. coli* to the brisket (Nersting & Jensen, 2002). It was concluded that reduced scoring and the new hide puller in combination significantly reduced the spread of *E. coli* to the brisket.

In the USA, steam vacuum is frequently used at several points along the beef slaughter lines, but the method needs national approval in EU member states if it is to be used to remove contamination before the veterinary inspection. In a Danish study on beef, steam vacuum was found more efficient than knife trimming for removal of dirt and bacteria from the surface (Dalsgaard et al. 2003). Used at strategic points along the slaughter line, steam vacuum is an efficient tool for removal of contaminations on carcasses on beef slaughter lines.

Dirty hides imply that the dehiding process must be carefully conducted by the operators. Removal of dust, dirt and dags after sticking and prior to dehiding can improve the hygienic quality of the carcass. In a previous study a 'De-dagger' was tested for its effect on the microbiological count (Rasmussen et al., 2004). The Australian 'De-dagger' removes visible dirt by mechanical work, vacuum and with or without water, without damaging the hide. It was concluded that cleaning dirty cattle with the 'De-dagger' significantly reduced the *E. coli* count on the carcasses.

DMRI has investigated the use of different hurdles such as lactic acid and hot water on the slaughter line for decontamination of beef carcasses (Tørngren, 2005a). Seven different combinations of acid, acid concentrations, water, temperature, method of application and time of treatments were tested. The most efficient method appeared to be spraying/flushing with 2% lactic acid at a temperature of 55°C for 10 seconds at a pressure of 1.5 bars through the nozzle, corresponding to a flow of 10 l/min.

Until now, the different hurdle technologies have only been studied one by one. In this Nordic project, the combined effect of several initiatives was studied.

Objectives

To assess the extent to which the microbiological quality of beef carcasses is improved by using several hygiene-improving interventions on the slaughter line:

- GMP (good working routines for slaughter)
- Optimised dehiding
- Cleaning dirty cattle on the slaughter line after sticking using a De-dagger.
- Steam vacuuming in selected areas with a risk of primary contamination
- Decontamination with lactic acid

Methodology

The experiments took place over a period of four slaughter days under normal production conditions in a representative Nordic meat plant with a slaughter line speed of 40-50 heads/hour. The design shown in fig. 1 included the following sampling of carcasses:

- 80 carcasses (20 carcasses/day), normal slaughter procedures (reference samples).
- 80 carcasses (20 carcasses/day), using GMP, De-dagger, Steam Vacuum at four locations (test samples)
- 80 carcasses (20 carcasses/day), using GMP, De-dagger, Steam Vacuum at four locations + lactic acid spray (brisket) (lactic acid samples)

All operators on the slaughter line were instructed to pay particular attention to GMP. This included specific focus on the procedures that could lead to contamination of the carcasses.

After shackling and sticking, dirt was removed from the belly with a De-dagger. The 'De-dagger' was developed by MLA, Australia and is now marketed in the EU by SFK Meat Systems, Denmark. The operator followed the slaughter line speed, but it is estimated that a trained operator can follow EU slaughter line speeds.

Before loosening the udder on lactating cows, a plastic apron was attached to the belly with bulldog clamps to allow the milk to flow on the apron instead of on the belly.

The Danish Meat Research Institute (DMRI) has developed a light (approx 300 g) Steam Vacuum handle (now marketed by SFK Meat Systems, Denmark) with nozzles that ensure an even temperature distribution all over the head of the handle. It is flexible for the operator to use in e.g. leg areas on the carcass. The admission of steam is controlled through the handle of the equipment to ensure that the operator does not burn himself. The plant was already applying steam vacuum on the outside round. Four additional steam vacuum handles were installed and used after scoring the hind legs, after scoring the belly, on the back after hide pulling and around the bung area.

A limited area (25 x 30 cm) of *M. cutanies trunci* (brisket) was sprayed with 0.8 l 55°C 2% lactic acid for a period of 10 seconds using four TEEJET TG SS 2.8 W nozzles from Spraying Systems CO with a pressure of 1.5 bars. The present use of lactic acid treatment requires dispensation in the EU, which is why the treated area was removed after microbiological testing.

For microbiological testing, samples were taken prior to chilling by swabbing each carcass in three locations measuring 600 cm^2 and in one location measuring 500 cm^2 with sterile gauze swabs. The locations were brisket (A), back (B), round (C) and pelvic region (D, 500 cm^2) (see figure 2). For the lactic acid treatment, only the brisket was swabbed. The sterile gauze swabs were moistened with 0.85% NaCl

buffered peptone water before sampling. Each swab was suspended in 25 ml of 0.85% NaCl buffered peptone water, stomached for 1 min. and then analysed for *E.coli* and APC. *E. coli* was obtained on Petri-film TM EC, incubated at 37°C for 48 hours. APC was obtained in Plate Count Agar, incubated at 20°C for 5 days (NMKL nr. 86, 3rd edition, 1999).

All counts were transformed to log values. These calculations and calculations of the standard deviations were made in Microsoft Excel, 2000. The statistical analysis was made with Proc. GLM or, where some counts were below the detection limit, with Proc. Lifereg (SAS Institute).

In connection with this experiment, the eating quality of 20 of the lactic acid treated samples were compared to 20 non-treated adjacent samples after vacuum-aging the brisket for 10 days at 2°C (Tørngren, 2005b). After opening the vacuum bags, four quality specialists evaluated the visual appearance, colour and raw meat odour on a fourpoint scale. In addition, a sensory profile was made of samples, which were oven cooked in roasting bags at 160°C for 60-90 min to reach a core temperature of 75C.

A trained panel evaluated the cooked meat flavour and odour.

Results & Discussion

There was a significant difference between the experiment and the reference for the aerobic count for the sample location Brisket (0,4 log units), while the difference between the experiment and the reference for the other sample locations was small and unsystematic (Figure 3).

The study also shows that decontamination with lactic acid is an efficient means of reducing the aerobic count as lactic acid resulted in a significant reduction of 3.5 log units compared to the reference before chilling (Figure 3).

Figure 4 shows the percentage of samples that were positive for *E. coli* before chilling. Only a few samples were positive - and those samples had very low counts - making it impossible to estimate average counts. However, there is a tendency towards a reduction in *E. coli* after lactic acid treatment.

The reference levels for aerobic count (1,0 – 2,6 log units before chilling) as well as for *E. coli* (14-38 % of samples positive for *E. coli* before chilling) were much lower in this project than in previous experiments including optimised dehiding (Nersting & Jensen, 2002), steam vacuuming (Dalsgaard et al., 2003) and use of De-dagger (Rasmussen et al., 2004), which indicates a considerable improvement in slaughter hygiene. This is considered to be the main reason why there were no significant differences between the reference and the test samples in this experiment. The slaughter of the reference group was performed under optimally hygienic conditions – and in order to further reduce the plate count level, decontamination is needed (e.g. lactic acid treatment).

Prior to this project, several hygiene-improving initiatives had already been implemented on the slaughter line at the host meat plant: limited scoring + optimal hygienic dehiding as well as steam vacuuming of all outside rounds just before the veterinary inspection. The results of the project indicate that the initiatives that have already been implemented are sufficient to obtain good slaughter hygiene.

To verify these findings, references were taken from three other Nordic beef plants, using identical sampling techniques. The results showed that the hygiene level

at two of these meat plants was just as good. On the other hand, the hygiene level at one of the meat plants, was slightly inferior.

Bacon *et al.* (2000) investigated microbiological quality of the hides and cattle carcasses at different stages in meat plants where 'multiple-hurdle-technology' was used for decontamination. Gill & Landers (2003) studied the microbiological effects of decontamination at four cattle meat plants. McEvoy *et al.* (2004) has written an article on microbial contamination of beef in relation to hygiene assessment based on the criteria stipulated in EU regulation 2001/471/EC. The methodologies, sample numbers and locations in these experiments are not fully comparable with the present study. Furthermore, the slaughter line speed was much higher in North America than in Ireland and the Nordic countries. However, the levels of APC and *E. coli* in the present study indicated good slaughter hygiene that could well match the results reported above, even without applying costly hurdle technologies.

Hence, good slaughter hygiene levels at European slaughter line speeds can be obtained through good operator training, careful instruction and motivated operators. The hurdle technologies can be justified under conditions in which operations get out of control, the animals are extremely contaminated and dirty, and acceptable microbiological results cannot be achieved by management alone. However, application of hurdle technologies must be customized individually according to the specific situation at the meat plant concerned.

At present, the use of the De-dagger is an expensive process that requires an extra operator. DMRI is looking into the possibilities of automating the De-dagger.

The use of steam vacuuming is a more effective method of removing faecal matter and impurities than trimming with a knife. Thus, it is recommended to install steam vacuum systems for removal of faecal matter and impurities.

In the EU, the use of lactic acid - or other organic acids - for decontamination is not legal presently. Regulatory changes must be made before these methods can be applied. Furthermore, when considering whether the introduction of treatment with organic acids is cost effective, it must be taken into account that the treatment involves investing in spray cabins.

Quality effects of lactic acid treatment

The results showed that the 2% lactic acid treatment did not affect the quality of the raw meat odour. The appearance of the meat was slightly inferior but still at an acceptable level. Lactic acid slightly reduced the cooked odour for the greasy and acidic odour parameters, and meat odour was somewhat reduced. The lactic acid treatment reduced the flavour intensity for the parameters meat, greasy and acidic flavour. However, the quality effects found in the study were considered to be of only marginal commercial importance.

Conclusions

There was only a limited reduction in the microbiological count for samples taken after the use of hygiene-improving interventions compared to the samples taken after the normal routine in the meat plant. The meat plant where the study was conducted already had a high level of slaughter hygiene. For that reason, the effect of the hygiene improving initiatives did not appear clearly.

Good slaughter hygiene can be obtained through care and consideration - also without the use of decontamination tools.

The lactic acid treatment with 55°C 2% lactic acid significantly reduced the count. The quality effects of the lactic acid treatment found in the study were considered to be of only marginal commercial importance. However, it must be questioned whether the introduction of the treatment with organic acids is cost effective when the microbiological load of the carcasses is as low as in this study.

Acknowledgements

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Tables and Figures

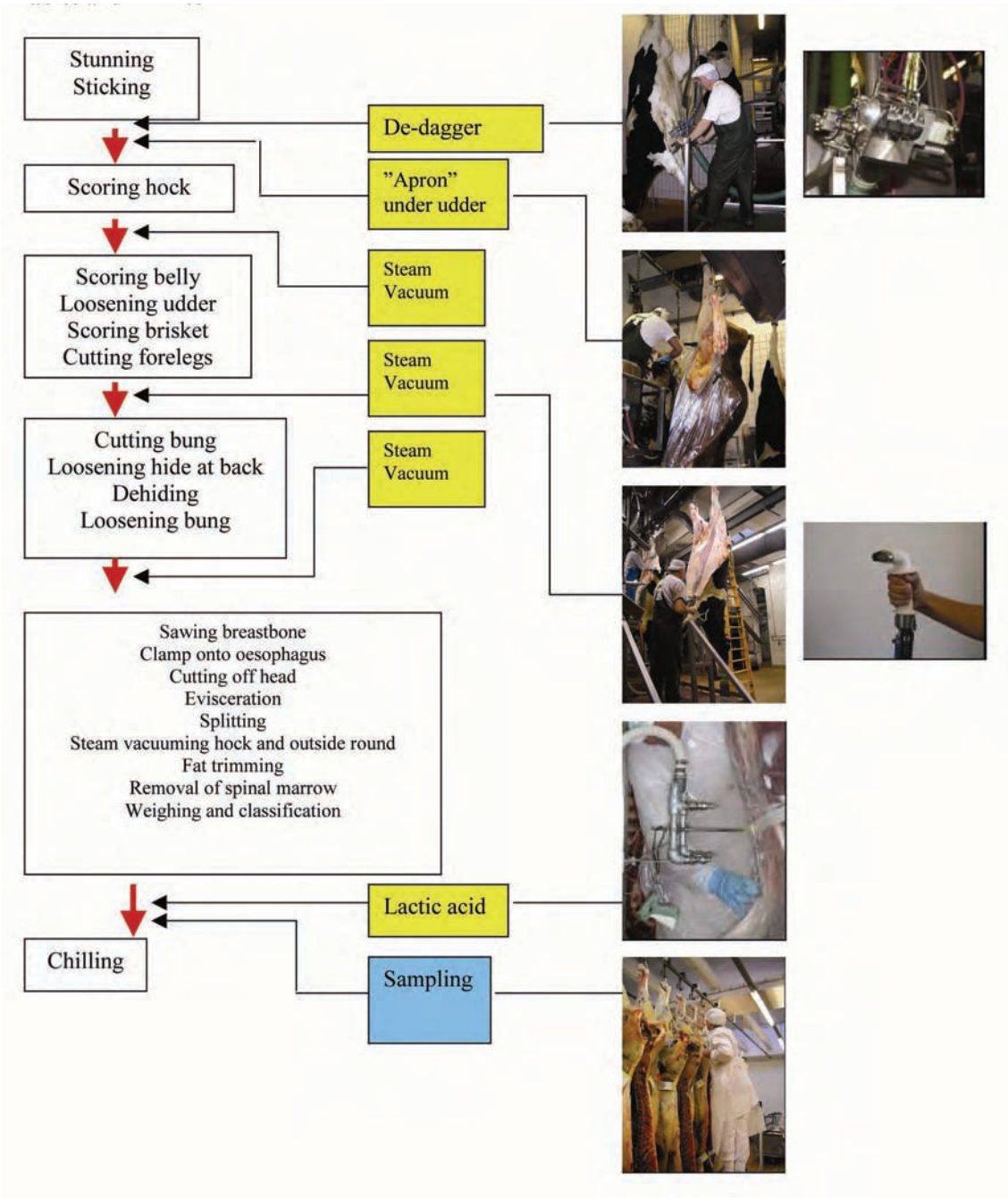

Figure 1: Schematic outline of the experimental design

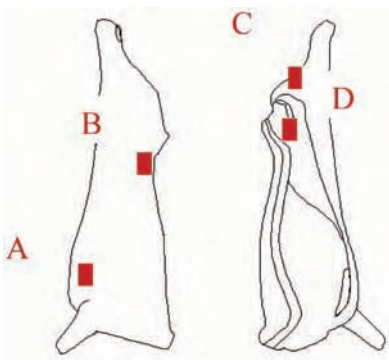

Figure 2: Microbiological sampling locations.

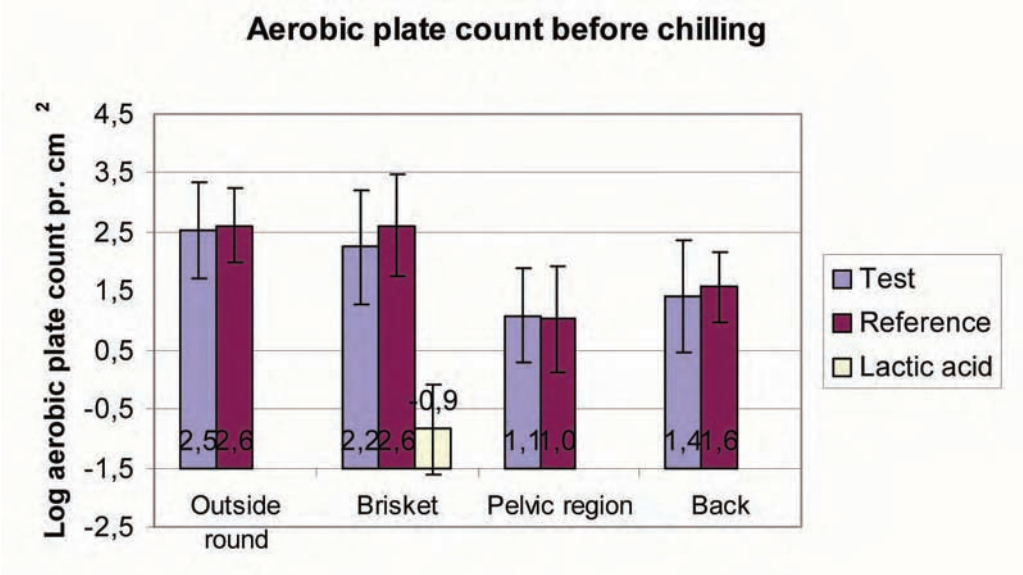

Figure 3: Aerobic plate count before chilling.
The average level of aerobic count (per cm2). There is a significant difference between the experiment and the reference in the sample Brisket (p=0.0062) but not on the other three sample locations. There is a significant difference between the samples treated with lactic acid and the reference in the sample Brisket (n=80 per bar).

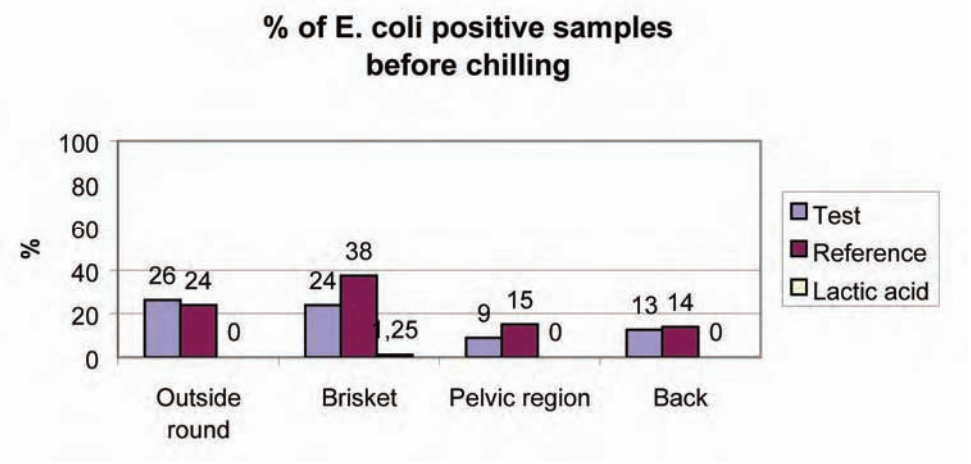

Figure 4: E. coli before chilling.
% samples positive for E. coli before chilling.
There is no significant difference between the experiment and the reference on any of the 4 sample locations. (n=80 per bar).