Steam Pasteurisation

INTERVENTION SUMMARY	
Status	Currently available
Location	Post slaughter
Intervention type	Surface treatment of carcases, primals or trimmings
Treatment time	10-15 seconds
Regulations	No restrictions, discouraged in the EU
Effectiveness	Reduced efficacy before hide removal, very high efficacy after hide removal (1-4 log units)
Likely cost	Depending on plant throughput from A$500,000 to A$1 million+
Value for money	Fair to good
Plant or process changes	Steam cabinets require a large amount of space
Environmental impact	High effluent loading High water use – recycling may be necessary
OH&S	Run-off may make floors slippery Risk of scalding from steam pipes and nozzles
Advantages	Can be used with other interventions
Disadvantages or limitations	Condensation may be an issue if cabinet is not well ventilated Results in surface bleaching initially, but meat colour recovers with time

Steam Pasteurisation

Steam pasteurisation is a fast, cost effective method, which is suitable for treating most meat products (Chen *et al.*, 2012). The use of steam has advantages over the use of hot water due to the potential energy released when steam condenses, thus achieving a more rapid rise in the surface temperature of the meat. Steam pasteurisation was approved for use in the USA in 1996 (USDA-FSIS 1996) where the standard recommends a temperature of 90°C or greater to be reached at the meat surface for 5-15 seconds. This is then followed by rapid cooling, usually immediately prior to the holding cooler. Commercial systems are available and in wide use in the USA and Australia, however the use of steam pasteurisation is not widely used in the EU.

Studies on whole carcasses have shown steam pasteurisation to be an effective technology. Nutsch *et al*. (1997) observed reductions in aerobic plate counts of around 1.5 log cfu/cm^2 and the reduction of coliforms to below detectable levels, following a 6-8 seconds treatment. Phebus *et al*. (1997) using a similar system obtained similar results and showed that the reduction was uniform over the surface of the carcass. More recently, Milios *et al*. (2011) trialled a steam pasteurisation system in a slaughterhouse in Greece and observed reductions of 0.72 log cfu/cm^2 and 0.95 log cfu/cm^2 in total viable count and *Enterobacteriaceae* on lamb carcasses, respectively. Another commercial trial showed significant reductions in *E. coli* and *Enterobacteriaceae* at sites where initial numbers were high, but it did not achieve complete elimination of these bacteria (Minihan *et al.*, 2003).

Combining two treatments, such as steam condensation on meat surfaces and hot water immersion, particularly chlorinated hot water, has been shown to effectively decrease the bacterial load on lamb (James *et al.* 2000). Dlusskaya *et al*. (2011) found evidence that the use of thermal pathogen intervention treatments in commercial slaughterhouses may select for heat resistant strains of *E. coli*. However, they suggest that the use of steam pasteurisation in combination with other treatments, such as acid washes, may help to prevent this. Smulders *et al.* (2012) also found that combining steam condensation (at sub-atmospheric pressures) with a hot water spray, achieved reductions of 3-4 log units in the levels of inoculated *Pseudomonas fragi* and *Yersinia enterocolitica* populations on pork skin. They recommend the use of steam condensation at sub-atmospheric pressures to minimise discolouration of the meat.

Steam pasteurisation for even a short (<15 seconds) duration results in initial surface greying of carcasses, but after 24 hours chilling, the meat returns to an acceptable colour (Phebus, 1996; cited in Huffman, 2002). A system of rapid cycling of steam under pressure and vacuum cooling has been designed which can give a 1.9 to 2.5 log reduction in *Listeria* numbers on beef after treatment for 48 milliseconds at 121°C (Morgan *et al.*, 1996a; 1996b). Steam has also been used on processed meat products; flash steam heating under pressure followed by cooling by evaporation can give up to 4 log reductions in microbial populations with a 30-40 seconds steam treatment time, without severely affecting colour or weight of beef frankfurter sausages (Cygnarowicz-Provost *et al.*, 1994).

For steam pasteurisation, the fixed cost for an installation would be around A$650,000 and the total cost A$0.75-0.80 per carcass.

Environmental considerations

Steam production requires a fair amount of energy, and water, although condensate may be collected, treated and recirculated. Steam pasteurisation is reported to be more efficient and requires less waste removal equipment than hot water washes (Nutsch *et al*., 1997)

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References

Cygnarowicz-Provost, M., Whiting, R. C., Craig, J. C. Jr (1994) Steam surface pasteurisation of beef frankfurters. Journal of Food Science **59**: 1339-1342.

Chen, J. H., Ren, Y., Liu, S. T., Bang, W. S., Yuk, H. G. (2012) Intervention technologies for ensuring microbial safety of meat: Current and future trends. Comprehensive Reviews in Food Science and Food Safety **11**: 119-132

Dlusskaya, E. A., McMullen, L. M., Ganzle, M. G., (2011) Characterisation of an extremely heat resistant Escherichia coli obtained from a beef processing facility. Journal of Applied Microbiology **110**: 840-849

Huffman, R. D. (2002) Current and future technologies for the decontamination of carcasses and fresh meat. Meat Science **62**: 285-294.

James, C., Thornton, J. A., Ketteringham, L, James, S. J. (2000) Effect of steam condensation, hot water or chlorinated hot water immersion on bacterial numbers and quality of lamb carcasses. Journal Food Engineering **43**: 219-225.

Milios, K., Mataragas, M., Pantouvakis, A., Drosinos, E. H., Zoiopolous, P. E., (2011) Evaluation of control over the microbiological contamination of carcasses in a lamb carcass dressing process operated with or without pasteurizing treatment. International Journal of Food Microbiology **146**: 170-175

Minihan, D., Whyte, P., O'Mahoney, M., Collins, J.D. (2003) The effect of commercial steam pasteurization on the levels of *Enterobacteriaceae* and *Escherichia coli* on naturally contaminated beef carcasses. Journal of Veterinary Medicine B **50**: 352-356.

Morgan, A. I., Goldberg, N., Radewonuk, E. R., Scullen, O. J. (1996a) Surface pasteurisation of raw poultry meat by steam. Lebensmittel-Wissenschaft und –Technologie **29**: 447-451.

Morgan, A. I., Radewonuk, E. R., Scullen, O. J. (1996b) Ultra high temperature, ultra short time surface pasteurisation of meat. Journal of Food Science **61**: 1216-1218.

Nutsch, A. L., Phebus, R. K., Riemann, M. J., Schafer, D. E., Boyer, J. E., Wilson, R. C., Leising, J. D., Kastner, C. L., (1997) Evaluation of a steam pasteurization process in a commercial beef processing facility. Journal of Food Protection **5**: 485-492.

Phebus, R. K., Nutsch, A. L., Schafer, D. E., Wilson, R. C., Riemann, M. J., Leising, J. D., Kastner, C. L., Wolf, J. R., Prasai, R. K. (1997) Comparison of steam pasteurization and other methods for reduction of pathogens on surfaces of freshly slaughtered beef. Journal of Food Protection **5**: 476-484.

Smulders, F. J. M., Wellm, G., Hiesberger, J., Bauer, A., Paulsen, P., (2012) The potential of the combined application of hot water sprays and steam condensation at subatmospheric pressure for decontaminating inoculated pig skin and muscle surfaces. Food Control **24**: 154-159.

USDA-FSIS (1996) Pathogen reduction; hazard analysis and critical control point (HACCP) systems; final rule. United States Department of Agriculture, Food Safety Inspection Service. Federal Register **61**: 38805-38989.