

Cold Treatments

INTERVENTION SUMMARY	
Status	Currently Available
Location	End of line chilling or freezing
Intervention type	Cooling of carcasses
Treatment time	24-36 hours
Regulations	Accepted worldwide
Effectiveness	Fair: 0.3-0.7 log reduction
Likely Cost	Depends on type of chilling system eg. blast, plate etc.
Value for money	Fair
Plant or process changes	Installation of powerful refrigeration units will be needed for ultra-low temperature chilling. Spray chilling will require tubing and spray nozzles installed. Most systems should retro-fit into existing chill rooms
Environmental impact	Refrigeration equipment requires energy.
OH&S	Spray systems result in wet, slippery floors. Ultra-low temperature chilling can result in ice formation inside the chill room. Staff should wear appropriate protective clothing including gloves.
Advantages	Spray chilling can give a whiter fat colour on the external primal surface.
Disadvantages or Limitations	The microbial reduction is slight Carcasses chilled to a very low surface temperature may be more difficult to bone and in most cases will incur a financial penalty at slower boning speeds.

Cold Treatments

Chilling slows the growth of most bacteria and temperatures just above the freezing point can kill or injure bacteria. Ice crystals may form within the bacteria and rupture the cell membrane, or chemical changes may occur which kill the organism. Chilling is the most widely used method for the preservation of meat (Ingram and Mackey 1976). Whatever the final microbial load of the meat, the maximum potential shelf-life will be achieved if the non-frozen meat is held at -1.5°C and for each $2\text{-}3^{\circ}\text{C}$ rise in temperature, the storage life will halve (Gill 1986). Air chilling is most commonly used in the Australian Meat industry, but spray chilling, as used in the US, or blast chilling (ultra-low temperature) may be considered.

Conventional chilling can reduce the microbial populations on carcasses by 0.3-0.7 log (Nortjé and Naude 1981; Thomas *et al.* 1977) and can reduce *E. coli* counts by up to 2 log over 24-36 hours (Bacon *et al.* 2000), but there is little effect on microbial populations when spray-chilling is used (Greer and Dilts 1988, Kinsella 2006)). Ultra-low temperature chilling has been suggested as potentially being more effective with regard to microbial inactivation, but researchers working on pork carcasses found little difference in the efficacy of conventional chilling versus ultra-low temperature chilling on the reduction of bacterial numbers on the carcasses, whether they were skin-on or skin-off (Chang *et al.* 2003). Spray chilling is commonly practiced in North American meat processing but has had limited uptake in Australia. Some studies have suggested the incorporation of an organic acid and acidified sodium chlorite into a spray chilling system. If an establishment chooses to apply this technology, it must satisfy the Food Standards Code definition of a processing aid (FSANZ 2006) i.e. there is no residue on the final product. Spray chilling should result in no increase in carcass weight. In export-registered establishments, the process will be subject to AQIS approval.

In the poultry sector, research has been focussed on crust freezing, where the outer surface of the meat is rapidly frozen, then thawed before the freeze can penetrate into the tissue. Freeze-thaw cycles can reduce *Salmonella* Typhimurium on poultry wings (Olson *et al.* 1981), using a combination of CO_2 freezing followed by microwave defrosting. These authors achieved substantial reductions in microbial load from initially already low levels of 0.9 log cfu/cm² to 0.02-0.05 log cfu/cm². It is important to note that as initial levels are reduced, it becomes increasingly difficult to remove the residual microbial contamination.

After a slaughter floor intervention step, some bacterial cells remain alive, but injured, and they can recover to cause spoilage or food-poisoning. Good chilling practices can elicit a further 0.5-2 log reduction in microbial load due to death of injured cells which, through their injury, are more susceptible to cold stress (Gill and Bryant 1997; McEvoy *et al.* 2004; Chang *et al.* 2003).

Novel Technology

There is a Japanese patented system called CAS (Cells Alive System) freezing which involves magnetism and modulated waves of cold air. Conventional freezing freezes the product from the outside in, and thus penetration of the cold to the centre of the food gets more difficult as the exterior freezes solid. The CAS technology claims to retain the texture and flavour of food by first supercooling the product, then freezing it. Supercooling is achieved by subjecting the target product with a low-intensity magnetic field, which lowers the freezing temperature of the product. Thus the entire body of the product can be uniformly cooled below freezing point without freezing occurring. Then, when the magnetics are turned off, the products', supercooled body freezes quickly and uniformly, suppressing the migration of fats and oils, and the formation of ice crystals. This technology is not yet available in Australia but is distributed by ABI (Japan).

Oscillating magnetic fields themselves have shown some promise as a means of reducing microbial numbers on foods. A technique involving passing foods through an electromagnetic coil emitting pulses of oscillating magnetic fields was patented in 1985 by Maxwell Laboratories Inc (Anon 1985), which claimed that microorganisms could be killed or deactivated without affecting the organoleptic properties of the food. The theory was that rapid variations in magnetic field would rupture the DNA within the microbial cells. The patent claimed 2-3 log reductions in microbial counts in milk, yoghurt, juice and dough, with minimal treatment times. A single pulse of intensity 5-50 Tesla at a frequency of 5-500 kHz, reduced microbial numbers by 2 log, and treatment times of 25 μ sec to 10 msec were used to successfully decontaminate milk, yoghurt and dough (Hofmann 1985, cited by Pothakamury *et al.* 1993).



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