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	0.3-0.7 log reduction
Likely cost	Depends on type of chilling system e.g., 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

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Chilling slows the growth of most bacteria, and temperatures just above the freezing point can kill or injure bacterial cells. Such process may cause ice crystals to form within the cells, and rupture their membrane or lead to chemical changes, which could result in cell death. Chilling carcasses at the end of processing has long been recognised as a way of maintaining quality and increasing storage time. 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 2-3°C rise in temperature, the storage life will halve (Gill 1986; Ingram and Mackey, 1976). Carcass chilling can be achieved using conventional chilling or air chilling (commonly used in Australia), spray chilling or blast chilling (ultra-low temperature). 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 h (Bacon *et al.*, 2000). A similar observation was also observed in other studies (Chang *et al.*, 2003; Gill and Bryant, 1997; McEvoy *et al.*, 2004). However, only little effect on microbial populations has been reported when spray-chilling is used (Greer and Dilts, 1988, Kinsella, 2006). Ultra-low temperature chilling has also 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 (Chang *et al.*, 2003).

Spray chilling is commonly practiced in North America, and is now being taken up in Australia. Some studies have suggested the incorporation of an organic acid or 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., no residue must be detected on the final products. 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 *S.* 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 to 0.02-0.05 log cfu/cm^2. It is important to note that as initial levels are reduced, it becomes increasingly difficult to remove the residual microbial contamination.

Novel Technology

There is a Japanese patented system called Cells Alive System (CAS), 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 takes time for thick items. 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 to 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 the 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 mean 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 µs to 10 ms were used to successfully decontaminate milk, yoghurt and dough (Hofmann, 1985, cited by Pothakamury *et al.,* 1993).

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