Effects of Dry Chilling on the Microflora on Beef Carcasses at a Canadian Beef Packing Plant

Yang Liu, Mohamed K. Youssef and Xianqin Yang*

Agriculture and Agri-Food Canada, Lacombe Research Centre,
6000 C & E Trail, Lacombe, Alberta, Canada T4L 1W1
Email: xianqin.yang@agr.gc.ca

Muscle tissues of carcasses from healthy animals are essentially free of bacteria until they are exposed during skinning. At this step, transfer of bacteria from the hide and the environment to the meat is unavoidable. Those bacteria may include high profile enteric pathogens, such as verotoxigenic *Escherichia coli*. With well controlled operations, the transfer of bacteria to the meat can be greatly reduced, but still elimination is not yet possible. *E. coli* and associated mesophilic pathogens do not grow significantly at temperatures below 7°C. Thus, it is required in Canada that beef carcasses be chilled to a surface temperature of 7°C or less within 24 h of carcass dressing, either through dry- or spray chilling. The most typical spray used by large beef plants is water. Spray chilling of the carcasses with water at the first stretch of chilling is done where weight loss is more prominent. Some plants spray carcasses with Inspexx (200 pm peroxyacetic acid) at the end of the chilling process, more for microbiological control than for controlling the weight loss. It is generally assumed that dry-chilling is microbiological beneficial due to surface desiccation. Despite the principal reason for chilling is to control bacterial growth, studies on the effects of dry-chilling process on the bacteria on carcass surfaces are rather limited, and the available information is often conflicting. Increase, decrease, or no change in numbers of indicator organisms on surfaces of carcasses resulting from different chilling processes or even from the same process at the same plant have been reported. The aim of this study was to determine the effects on beef carcasses microflora of a commercial dry chilling process and explore whether dry-chilling can be used as an effective pathogen control intervention. This study was conducted at a commercial beef packing plant where carcasses are routinely dry-chilled for three days before fabrication.

To determine the numbers of aerobes, coliforms and *Escherichia coli,* groups of 25 carcasses were selected at random and sampled when the chilling process commenced and after the carcasses were chilled for 1, 2, 4, 6, 8, 24 and 67 h. Temperatures of the surfaces of the shoulder, rump and the deep into the hip of the carcass were monitored. Ambient air conditions including air temperature, velocity and relative humidity (RH) were also monitored throughout the chilling process. The chiller was operated at 0°C with an off-coil RH of 88%. The air velocity was 1.65 m/s when the chiller was loaded.

Initial RH of the air in the vicinity of carcasses varied with locations of carcasses in the chiller and decreased rapidly during the first hour of chilling (Fig 1). Average times for shoulder surfaces, rump surfaces and the deep leg of carcasses to reach 7°C were 13.6 ± 3.1, 16.0 ± 2.4 and 32.4 ± 3.2 h, respectively (Fig 2).

The numbers of recoverable aerobes, coliforms and *E. coli* on carcasses before chilling were 5.33 ± 0.42, 1.95 ± 0.77, 1.42 ± 0.78 log CFU/4,000 cm2, respectively. The number of aerobes on carcasses was reduced by 1 log unit by the first hour of chilling and the subsequent 23 h of chilling, respectively. There was no significant difference ($P > 0.05$) between the numbers of aerobes recovered from carcasses after 24h and 67h of chilling. The change in the numbers of the indicator organisms approximated a bi-phasic process (Fig. 3). The total numbers of coliforms and *E. coli* on carcasses before chilling and after the first hour of chilling were 3.86 and 3.30, and 2.24 and 2.04, respectively. The subsequent 23 h of chilling reduced the numbers of both groups of organisms by a further log unit. No coliforms or *E. coli* were recovered after 67 h of chilling.

Conclusion:

The findings of this study show that reductions of up to 2 log units of aerobes, coliforms and *E. coli* could be attained within a 24-h chilling period by a chilling process with appropriate parameters. As such, the dry

chilling process can be employed as an alternative to antimicrobial solutions for controlling microbiological contamination of beef carcasses, particularly at smaller abattoirs where it may not be practicable for implementation of antimicrobial interventions used by large plants and at places where chemical free meat products are in high demand.

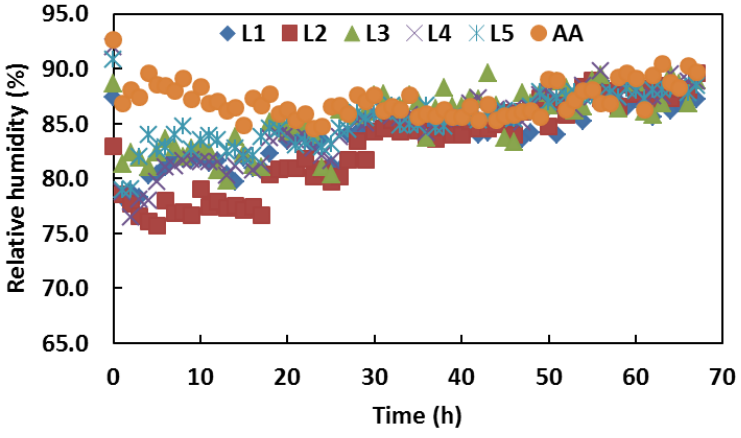

FIGURE 1 Histories of relative humidity of ambient air (AA) and of air close to the surfaces of carcasses at various locations during a commercial dry chilling process. Carcass locations were L1, the middle of the first row; L2, the front of the second row; L3, the end of the second row; L4, the middle of the third row; L5, the middle of the fourth row.

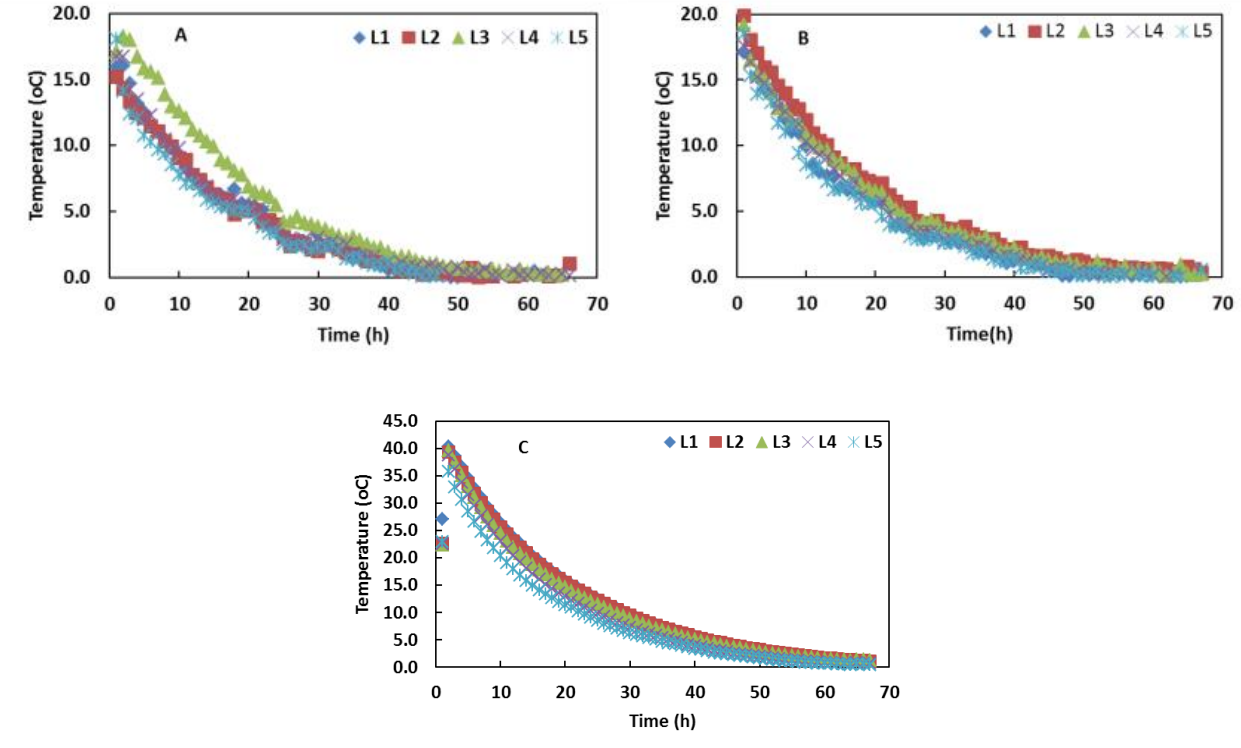

FIGURE 2 Temperature histories of shoulder surfaces (A), rump surfaces (B) and deep into the hip (C) of carcasses at various locations during a commercial dry chilling process. Carcass locations were L1, the middle of the first row; L2, the front of the second row; L3, the end of the second row; L4, the middle of the third row; and L5, the middle of the fourth row.

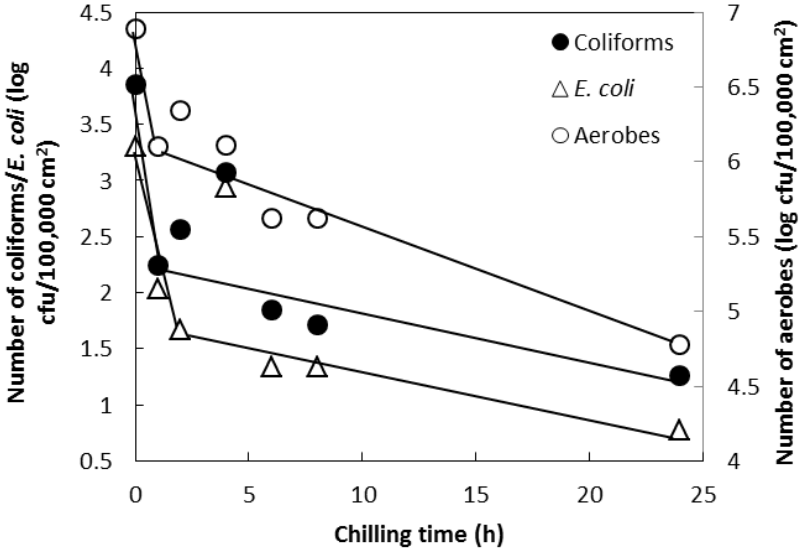

FIGURE 3 Log total numbers of aerobes, coliforms and *Escherichia coli* recovered from beef carcasses at a commercial plant during a dry chilling process.