THE TEMPERATURE OF HAMS, MEASURED SUBCUTANEOUS AND IN THE BICEPS FEMORIS DURING SLAUGHTER AND CHILLING.
II. CHANGES IN TEMPERATURE DURING MODERATE CHILLING COMPARED TO FORCED CHILLING AND ASSOCIATED EFFECTS.

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SUMMARY

Forced chilling (-5 °C, 120 min or -30 °C, 30 min) resulted in significantly lower subcutaneous and biceps femoris temperatures compared to conventional chilling (4 °C) during corresponding periods. Carcass weight losses were about 2 % till 24 hrs post mortem after conventional and forced chilling (-5 °C, 120 min). 'Ultra' rapid chilling (-30 °C) resulted in lower losses, decreasing from about 1.7 % to 1.3 % at increasing (1 - 4 m/s) air velocities.

No differences in drip and sarcomere length could be demonstrated between the various chilling procedures. Warner-Bratzler shear force was slightly higher ($P < 0.05$) following forced chilling (-30 °C) at the highest (4 m/s) air velocity compared to conventional chilling.

INTRODUCTION

Changes in temperature occurring subcutaneously and intramuscularly from stunning/exsanguination till the end of scalding have already been described (VAN DER WAL et al., 1994). It became clear that the subcutaneous temperature increases rather easy from about 30 °C at the moment of stunning to about 53 °C during scalding, after which a sharp drop occurred. Muscle temperature remained constant till scalding, followed by a slight increase of about 1 °C. After evisceration and weighing/grading commonly carcasses are chilled. Chilling can be performed according to various procedures, among others by conventional chilling at refrigerator temperatures (4 °C), or forced chilling at temperatures below 0 °C and higher air velocities. As these methods differ, their effect on skin and muscle temperature may be different too. Therefore, continuous temperature registrations have been performed during conventional as well as various types of forced chilling, both subcutaneously and intramuscularly.

MATERIAL AND METHODS

Experiments were carried out with 6 batches of 6 crossbred slaughter-pigs, weighing 105 - 110 kg. Chilling conditions were either conventional at 4 °C, air velocity 0.5 m/s, or forced chilling at -5 °C during 120 min, or at -30 °C during 30 min (air velocities 1, 2 or 4 m/s), followed by conventional (= equalization) chilling. Each half-carcass was treated according to one of the six forced chilling conditions, while the complementary half-carcass was chilled conventionally. All chilling experiments lasted 24 hrs.

Continuous temperature registrations were performed with copper-constantan thermocouples (outer diameter 2.5 mm) connected to a recorder. The thermocouples were placed subcutaneously and intramuscularly in the m. biceps femporis (BF) of both carcass sides. The thermo-physical properties were calculated with the computer programme Costherm (MILES et al., 1983). The temperature profiles were calculated using a finite-element method. For the chilling experiments a mathematical cylinder model for heat transport was preferred instead of a flat layer model as used to evaluate temperature increases at scalding.

Losses in carcass weight were determined by comparing the weights of each half-carcass before and after the various chilling procedures. Furthermore, meat quality of the lumbar part of the longissimus muscle

was determined using the amount of drip absorbed in filter paper (KAUFFMAN et al., 1986), the Warner-Bratzler shear force value of heated muscle samples (VAN DER WAL et al., 1988) and the length of sarcomeres (VOYLE, 1971).

RESULTS AND DISCUSSION

Forced chilling, either at -5 °C (120 min), or at -30 °C (30 min) resulted in significantly lower skin and muscle temperatures compared to conventional chilling (4 °C) during comparable chilling periods (Table 1). After forced chilling, skin temperature initially showed a rise, followed by a decrease according to an asymptotic curve. An explanation for this phenomenon, which was not observed in the m. biceps femoris, is that when carcasses are railed from forced chilling conditions into the conventional chiller, condensation of moisture occurs on the much colder surfaces of the rapidly chilled carcasses.

With conventional chilling losses in carcass weight were about 2 % in 20 to 24 hrs post slaughter. Comparable results were obtained when forced chilling (-5 °C, 120 min) was used followed by equalization chilling. After forced chilling with much lower temperatures (-30 °C, 30 min), however, losses in carcass weight decreased with increasing air velocity from about 1.7 % via 1.5 % to 1.3 %, compared to conventional chilling. This is in line with other results from literature (JAMES et al., 1983). Therefore, it might be concluded that 'ultra' rapid chilling has advantages over conventional chilling. Questionable, however, is the benefit of lower carcass weight loss when compared to the increasing demand for kinetic energy (related to the cube of the air velocity) with air velocities.

Meat quality characteristics showed no differences between the various chilling conditions when drip according to the filter paper method was taken into consideration. The same could be said for the parameters for meat tenderness, i.e. sarcomere length (SL), although slightly shorter SL's (not significant) were present at higher air velocities. This latter tendency was accompanied by a slightly higher mean Warner-Bratzler shear force value in the muscle samples of the carcasses chilled at -30 °C (4 m/s). Differences in W-B values, found after the conventional and the forced chilling procedures, were less than 4 Newton. It is questionable if consumers are even able to discriminate between shear force values that differ so little. This does not mean, however, that we do not have to be aware for negative effects of chilling on tenderness as a consequence of cold shortening using chilling conditions as described before.

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