Versuche zur Vermeidung der "Kälteverkürzung" (cold shortening) beim Rind

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Verbesserte Methoden zur Abkühlung von Fleisch haben zum Auftreten der Kälteverkürzung in bestimmten Teilen von Rinderschlachtkörpern geführt. Es wurden Methoden zur Vermeidung der Kälteverkürzung studiert. Langsame Abkühlung unter der Periode pre rigor und Lagerung bei 10°C und 14°C resultierte in geringfügig gesenkten Scherwerten bei der Lende ohne einen mikrobiologischen Verderb des Fleisches zu verursachen. Die Schrumpfung war jedoch wesentlich höher. Elektrische Stimulans unmittelbar nach Abblutung und schneller Abkühlung sowie eine 4-stündige Verzögerung bei Zimmertemperatur resultierten in einer signifikanten Senkung der Scherwerte. Sowohl die Schrumpfung als auch die mikrobiologischen Daten haben im Vergleich zu Normalwerten keine Abweichungen aufgewiesen.

Experiments to avoid cold shortening in beef

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Improved methods of chilling meat have led to the development of cold shortening in certain parts of beef carcasses. Methods to avoid cold shortening have been studied. Slow chilling rates during the pre-rigor period, storage at 10°C and 14°C, slightly lowered the shear force values of the loin without causing microbial spoilage of the meat. The shrinkage, however, was considerably higher. Electrical stimulation immediately after exsanguination and a rapid cooling, after a four hours delay in room temperature, resulted in a significant lowering of the shear force values. The shrinkage and the microbial counts were not diverging from normal values.

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Quelques expériences cherchant à éviter le raccourcissement par le froid

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L'amélioration des méthodes de réfrigération de la viande a entraîné un développement de raccourcissement par le froid dans certaines parties des carcasses de boeuf. On a étudié des méthodes d'éviter le raccourcissement dû au froid. Des vitesses de réfrigération lentes pendant la période pre rigor, un stockage au 10°C et au 14°C ont diminué légèrement les valeurs de la résistance de l'échine à la force coupante sans produire des dégâts microbiens dans la viande. Cependant la perte de poids était considérablement plus grande.

On entreprit une stimulation électrique immédiatement après l'exsanguination, suivie d'un refroidissement rapide après un délai de quatre heures dans une température ambiante dont il résulta une diminution importante des valeurs de la résistance à la force coupante. Le rétrécissement et le nombre de microbes ne déviaient pas des valeurs normales.

Эксперименты по предотвращению сокращения массы говядины под влиянием холода

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Улучшение методов охлаждения мяса привело к развитию сокращения массы под влиянием холода в некоторых частях туш крупного рогатого скота. Были исследованы методы предотвращения сокращения массы мяса под влиянием холода. Медленные скорости охлаждения в pre-rigor период, хранение при 10°C и 14°C снизили слегка показатели сопротивления срезу в поясничной части туши, не причиняя при этом микробной порчи мяса. Однако усушка при этом была значительно выше. Электрическая стимуляция сразу же после истечения крови и быстрое охлаждение после выдержки в течение четырех часов при комнатной температуре, дали в результате значительное снижение показателей сопротивления срезу. Усушка и количество микроорганизмов не отклонялись от нормальных показателей.

Experiments to avoid cold shortening in beef

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Introduction

Fast chilling of beef carcasses immediately post mortem, before the onset of rigor mortis, has been shown to affect the ultimate tenderness of meat (Newbold & Harris, 1972). Muscle shortening during this period is the major cause of meat toughness and far outweighs live animal factors such as breed, age and sex in determining eating quality (Davey, 1969; Locker et al., 1975). Pre-rigor meat shortens by early fast chilling - the phenomenon known as cold shortening (Locker & Hagyard, 1963).

The fast chilling methods for beef carcasses were introduced to reduce carcass shrinkage and microbial growth, but with these chilling methods parts of the carcasses undergo cold shortening. To avoid cold shortening the chilling rate must be slowed down (Smith et al., 1976; Fields et al., 1976) or the rigor mortis process must be hastened by electrical stimulation (Carse, 1973; Davey et al., 1976).

The present study was conducted to investigate the effects on shrinkage, bacterial growth and tenderness of high temperature conditioning or electrical stimulation before chilling as compared to the normal procedures for chilling beef carcasses.

Materials and methods

At the Kristianstad-Blekinge abattoir (KBS) experiments were conducted involving carcasses from 30 lean steers with the carcass weight ranging between 200 and 300 kg. The carcasses were devided into four different groups. One group was electrically stimulated immediately after exsanguination with the use of four electrodes, one for each back leg and one on each side of the neck. The stimulation continued for 4 minutes with half wave rectified sinusoidal 50V pulses, 50 pulses · sec^{-1}. The polarity was reversed every half minute.

All the carcasses were dressed and sawn into sides according to normal commercial practice.

Chilling procedure

Four different chilling procedures were compared.

The KBS commercial chilling procedure was applied to 6 carcasses. The carcasses were chilled at $-2^{o}C$ for 4 hours before transferring to $+2^{o}C$ for a further 24 hours.

High temperature conditioning was applied to 18 carcasses. Twelve carcasses were conditioned at $+10^{o}C$ and six carcasses at $+14^{o}C$ respectively until the pH reached 5.7 (7 - 8 hours). The temperature was then gradually lowered to $+2^{o}C$ and the carcasses were kept in the coolers for a further 24 hours.

The six electrically stimulated carcasses were kept in ambient temperature until the pH reached 5.7 (4 hours) and then treated according to the commercial procedure.

The cooling procedures are graphically visualized in figure 1.

The humidity in the coolers was kept at 80%. The air velocity was 5 m/s in the $-2^{o}C$-cooler and 0.5 m/s in the $+2^{o}C$-cooler. After chilling the meat was cut, vacuum packed and kept in $+2^{o}C$ for 14 days.

1) Kristianstad-Blekinge Slakteriförening, Box 568, S-291 25 Kristianstad, Sweden.

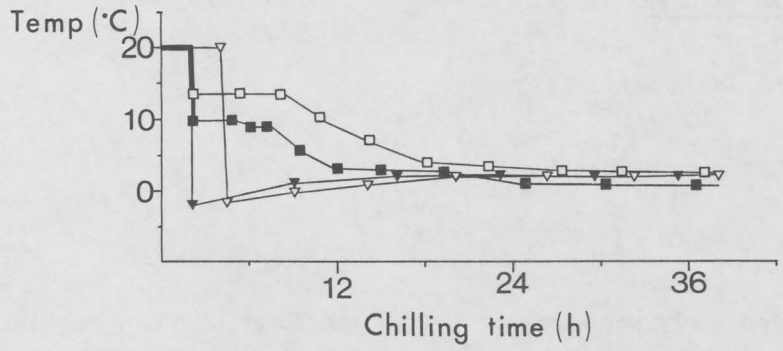


Fig. 1. The resulting environmental temperatures after four different chilling procedures. Commercial treatment ▼——▼ , conditioning in +10°C ■——■ , conditioning in +14°C □——□ , electrical stimulation ▽——▽ .

Measurements

Temperatures were recorded continuously on a multipoint temperature recorder (Chessell) with copper-constantan thermocouples in longissimus dorsi (at a point opposite the third lumbar vertebra) at a depth of 2 cm, in triceps brachii at 1.5 cm and in biceps femoris at 1.5, 4 and 8 cm depth.

A Metrohm pH Meter E 488 with a combined probe electrode (EA 152) was used to record pH changes. Measurements were made directly by inserting the electrode into the carcass close to the temperature measurement sites.

The evaporative losses during chilling were measured by weighing the carcasses before and after chilling.

Shear force values of the loin were determined by the use of a Warner-Bratzler apparatus. The technique used was described by Szcesniak & Torgeson (1965) with modifications described by Lundström et al. (1977).

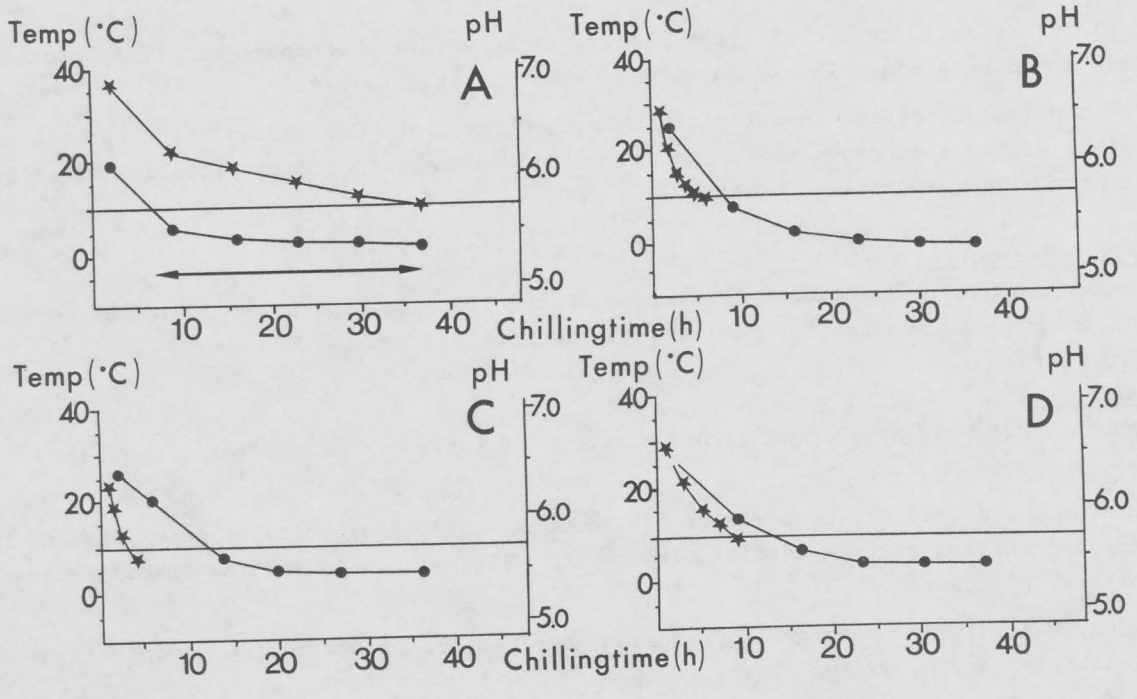
For bacteriological analysis surface samples were collected by the use of a borer 20 mm in diameter. The bore samples were shaken in sterile peptone water according to the procedure described by Nickels et al. (1976). The bacteriological analysis included determination of total plate count (Tryptone Glucose Extract Agar at +30°C for 3 days) and coliform organisms (Violet Red Bile Agar at +37°C for 1 day).

Results and Discussion

Longissimus dorsi, a muscle easy to chill, showed the slowest drop in pH of the muscles tested. This muscle therefore seemed to be the most interesting in respect of fast chilling and the occurrence of cold shortening. The temperature-pH decline in longissimus dorsi is illustrated in figures 2 to 5. The commercial chilling method showed the prerequisite conditions for cold shortening to appear (pH > 5.7, temperature < 10°C, Bendall, 1974) in longissimus dorsi at the location measured. The high temperature conditioning hastened the pH-decline, but the most rapid drop in pH was obtained after electrical stimulation. The latter depended partly on the immediate response of stimulation giving a 0.40 unit pH-drop but also on the initial slow chilling and the faster rate of pH-decline (dpH/dt) described after cessation of the stimulation (Chrystall & Devine, 1978). All the experimental procedures precluded the occurence of cold shortening conditions.

The normal mean shrinkage at KBS using the commercial chilling procedure was 1.3 weight % in one day. The electrically stimulated sides showed only a slightly elevated shrinkage up to 1.4 weight %. With the two high temperature conditioning methods the carcasses had to be chilled for at least 1.5 days to reach the necessary temperature of 8°C in the deeper parts and the evaporative losses increased to 2.2% and 2.5% respectively.

The bacteriological results are shown in table 1. All the treatments showed acceptable bacteriological results and no coliforms were detected. This is in agreement with the results of ohter workers (Braathen, 1971; Glover et al., 1977).
The results of the shear force determinations are also presented in table 1.



Figures 2-5. The temperature and pH decline in longissimus dorsi after four different chilling treatments. A = commercial treatment, B = conditioning in +10°C, C = electrical stimulation, D = conditioning in +14°C. Temperature ●——● , pH ✶——✶ , cold shortening conditions ◄——►.

Chilling treatment	Bacterial counts in logaritms total plate count/cm²		Shear force values (lb) (mean and standard deviation)		
	neck	sirloin	Before chilling	After chilling	After ageing
Commercial chilling	3.25-4.85	<2.00-3.46	7.15 ± 0.98	5.78 ± 0.42	3.82 ± 0.74
Conditioning +10°C	2.30-4.39	<2.00-2.90	7.01 ± 1.21	6.09 ± 1.07	3.37 ± 0.65
Conditioning +14°C	2.73-3.88	2.25-3.38	6.32 ± 1.89	5.60 ± 0.85	3.25 ± 0.61
Electrical stimulation	<2.00-4.69	<2.00-2.25	-	6.17 ± 0.21	2.58 ± 0.27

Table Bacterial surface counts after completion of the chilling period of the four different carcass treatments and shear force determinations of samples from longissimus dorsi with Warner-Bratzler apparatus.

The best results were obtained after electrical stimulation and the difference between commercially treated and electrically stimulated carcasses was statistically significant ($P < 0.01$). Differences between high temperature conditioned and commercially treated carcasses were not significant.

Earlier comparisons at KBS between test panel ratings and shear force determinations have shown that shear force values below 3 arbitrary units are fully acceptable. The only samples that after a 14 days´ ageing period show mean shear force values below 3 are the electrically stimulated.

Since all the experimental procedures prevented the occurence of cold shortening, the better tenderization effects achieved by electrical stimulation cannot only be explained by the precludence of this phenomenon. Smith et al. (1977) suggested that the

rapid decrease in muscle pH after electrical stimulation enhanced autolytic proteolysis. This could be a possible explanation of the results obtained.

The conclusions of the investigation are that the electrical stimulation was the best method of the treatments tested in producing tender beef of good microbiological quality without high evaporative losses.

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